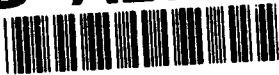


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WL-TR-91-8012

**ACTIVITY and INFORMATION MODELING  
METHODOLOGY ASSESSMENT**

Task Order Final Report for Period May 1990 - November 1990

April 1991

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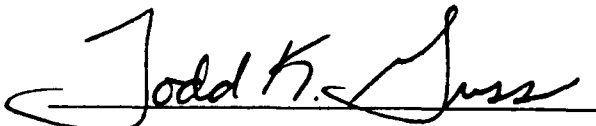
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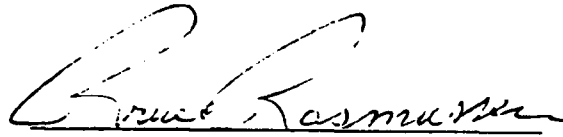
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REPORT DOCUMENTATION PAGE			FORM APPROVED OMB NO. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington DC 20503.				
1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE April 1991		3. REPORT TYPE AND DATES COVERED Final Technical Report May 90 - Nov 90
4. TITLE AND SUBTITLE Activity and Information Modeling Methodology Assessment			5. FUNDING NUMBERS F33615-89-C-5708 PE 78011F PR 3095 TA 06 WU 19	
6. AUTHOR(S) Joint Effort - Clarence G. Feldman, Softech Richard R. Preston, BDM Paul S. Thompson, Control Data			For: Lawrence Associates, Inc. 5100 Springfield Pk, Suite 509 Dayton, Ohio 45431	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) SofTech 460 Toten Pond Rd Waltham, MA 02154-1960			BDM International Richard R. Preston 1900 Founders Drive Dayton, OH 45420	
Control Data Corporation 2970 Presidential Drive Dayton, OH 45324			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Air Force Lt. Todd Guss WL/MTIA (513) 255-7371 WPAFB, OH 45433-6533			10. SPONSORING/MONITORING AGENCY REP NUMBER WL-TR-91-8012	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT  The objective of this program was to conduct a top-level assessment of activity (IDEF-0) and information (IDEF-1x) modeling methods needed to support overarching enterprise framework applications.  The results provide a preliminary strategic plan, or blueprint, tailored to the needs related USAF and industry requirements for integrated information modeling capabilities. The plan is a systematic and incremental approach for strategic improvements relative to enterprise framework applications.				
14. SUBJECT TERMS Assessment Requirements, Framework Initiatives, Survey Procedure, Survey Questionnaire Literature Review			15. NUMBER OF PAGES 80	
			16. PRICE CODE N/A	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASS OF THIS PAGE. Unclassified	19. SECURITY CLASS OF ABSTRACT Unclassified	20. LIMITATION ABSTRACT III.	

## TABLE OF CONTENTS

SECTION 1 EXECUTIVE OVERVIEW .....	1
A. Assessment Requirements.....	1
B. Background.....	1
C. Highlights of Accomplishments.....	2
C.1 Active Framework Initiatives	
C.1.1 Discussions with ESPRIT's Program Manager for CIM-OSA .....	2
C.1.2 IBM Meeting .....	2
C.2 IDEF U.G.....	3
C.3 Needs of the CALS Community.....	3
C.4 Survey of User Needs.....	4
D. Assessment and Recommendations.....	4
SECTION 2 INDUSTRY DIRECTIONS .....	6
A. Frameworks.....	6
B. Methods.....	7
C. Technologies.....	8
SECTION 3 ASSESSMENT MISSION .....	14
SECTION 4 STRATEGIC PLAN .....	16
A. Assessment Results.....	16
B. Recommendations.....	17
B.1 Presentation Format and Content .....	17
B.2 Specific Recommendations .....	18
B.3 Prioritization of Recommendations .....	19
C. Suggested Roadmap.....	31
SECTION 5 SYNOPSIS OF ACCOMPLISHMENTS .....	32
A. IDEF User Group Meeting.....	32
B. CIM-OSA Support Assessment.....	32
C. Survey of Needs.....	33
C.1 Source List and Assignments.....	33
C.2 Cover Letter and Generic Question List.....	34
C.3 Summary of Survey Results.....	34
D. Meetings.....	34
E. Final Report, Including Recommendations.....	35
F. Literature Review.....	35
G. Summary.....	36
APPENDIX A SURVEY OF THE INDUSTRY .....	A-1
A.1 The Survey Procedure.....	A-1
A.2 The Survey Questionnaire.....	A-1
A.3 Source List.....	A-7
A.4 Response to Questionnaires.....	A-8
APPENDIX B MEETING MINUTES .....	B-1
B.1 Kickoff Organizational Meeting.....	B-1
B.2 Rochester, Minnesota CIM-OSA Meeting.....	B-3
B.3 July Working Session.....	B-8
B.4 August Meeting and IDEF Steering Committee Presentation...	B-12
B.5 Final Task 4 Team Meeting.....	B-13
B.6 IDEF User Group Meeting.....	B-14
APPENDIX C BIBLIOGRAPHY .....	C-1

**TABLE OF CONTENTS**  
**(Cont)**

APPENDIX D	CIM-OSA/Idef MARRIAGE .....	D-1
D.1	IBM Document .....	D-1
D.2	Task 4 Team Document .....	D-6

## LIST OF FIGURES

Figure 1-1	IDEF Coverage of CIM-OSA Lifecycle Steps .....	3
Figure 2-1	Categories of Frameworks (EIF) .....	7
Figure 3-1	The Assessment Mission .....	14
Figure 4-1	General Matrix Mapping of Problems to Solutions .....	16
Figure 4-2	Presentation Format for Recommendations .....	17
Figure 4-2.1	Recommendation "1" .....	18
Figure 4-2.2	Recommendation "2" .....	19
Figure 4-2.3	Recommendation "3" .....	20
Figure 4-2.4	Recommendation "4" .....	21
Figure 4-2.5	Recommendation "5" .....	22
Figure 4-2.6	Recommendation "6" .....	23
Figure 4-2.7	Recommendation "7" .....	24
Figure 4-2.8	Recommendation "8" .....	25
Figure 4-2.9	Recommendation "9" .....	26
Figure 4-2.10	Recommendation "10" .....	27
Figure 4-2.11	Recommendation "11" .....	28
Figure 4-3	Natural Ordering of Recommendations .....	29
Figure 4-4	Recommendation Ranking Matrix .....	30
Figure 4-5	IDEF Enhancement Roadmap .....	31
Figure A-1	Summary of Identified Needs from Response .....	A-9

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## **SECTION 1**

### **EXECUTIVE OVERVIEW**

#### **A. Assessment Requirements**

The methods assessment was performed as Task 4 under the Manufacturing Technologies Special Studies (MTSS) program, at the direction and sponsorship of the Integration Technology Division, Manufacturing Technology Directorate, Wright Research and Development Center (WRDC/MTI). The task requirement was to conduct a top-level assessment of activity (IDEF-0) and information (IDEF-1x) modeling methods needed to support overarching enterprise framework applications. The results, as presented in Section 4, provide a preliminary strategic plan, or blueprint, tailored to the needs of related USAF and industry requirements for integrated information modeling capabilities. The plan is a systematic and incremental approach for strategic improvements relative to enterprise framework applications.

#### **B. Background**

The generation and control of enterprise operations information and related activities associated with procurement, logistics, engineering, production, product development, product deployment/service, and business development have evolved as critical elements in the economics of computer integrated manufacturing. Computer applications have introduced new and costly complexities on how we control and integrate the same enterprise information within different operating environments: local (single site), wide area (multi-site), global (multi-national). Often, different computer systems and operating standards are employed in the same operating environment, making it costly and cumbersome to communicate within a single operating organization, not to mention the deployment, servicing, and supplier environments which also must be considered. In order to support the defense industrial base, which has strong influence and implications in the commercial sector, it is extremely critical that adequate methods, tools, standards, and life cycle strategies be established on a global basis for modeling, analysis, and integration support of total enterprise operations and product description development and application.

Activity and information modeling methods and tools have proven their value in improving Enterprise operations, for example by identifying cost-saving process improvements, enabling Total Quality Management (TQM) implementations, providing more timely manufacturing and financial data, etc. However, these methods have not been optimized in terms of scope, economics, simplification, and automation tools. A broad based set of complementary modeling and analysis methods and tools are needed to conduct effective top-down analyses of activities on a global architecture basis, as well as an optimized set of modeling methods and tools to support bottom-up

design. The effectiveness of the IDEF Methods has proven valuable many times over for activity and information modeling on a company-by-company approach for application. Based on assessment information available today, there is sufficient justification to support using the existing activity and information modeling methods as the basis for enhancements and improvements that will address the needs of today's global enterprise operations.

## **C. Highlights of Accomplishments**

This section provides a synopsis of key information sources that served as milestone inputs for achieving assessment results. Many additional contributions were provided by equally important sources as reflected throughout the report.

### **C.1 Active Framework Initiatives: CIM-OSA**

In the area of active framework initiatives, the Task 4 Team focused on the European "Computer Integrated Manufacturing - Open System Architecture" (CIM-OSA) Framework as being the broadest scope as well as the most advanced information source for Task 4 purposes

#### C.1.1 Discussions with ESPRIT's Program Manager for CIM-OSA

In May 1990, following an overview presentation on the CIM-OSA Program at the IDEF-UG Conference, Task 4 Team Members met with the CIM-OSA Program Manager. The purpose of the meeting was to focus on a working relationship that would support an assessment of IDEF applications and enhancements needed to support broad based enterprise frameworks on the same scale addressed by the CIM-OSA framework. The meeting resulted in a course of action that would lead to complimentary initiatives. The course of action focused on needed coordination activities leading to a three-day workshop with IBM representatives familiar with the CIM-OSA Framework and Guidelines. The workshop was intended to provide an understanding of the CIM-OSA Framework as well as the modeling needs that could be met by the current IDEF Method and to establish recommendations that reflect needed enhancements to the IDEF Modeling methods to support a large percentage of the CIM-OSA needs.

#### C.1.2 IBM Meeting

Following a series of Air Force and IBM coordination activities, a three-day meeting with IBM in Rochester, Minnesota was established. IBM is a participant in the CIM-OSA effort in Europe, and this was an opportunity for the Task 4 Team to meet with personnel having in-depth technical knowledge of CIM-OSA. During the workshop, IBM conducted a review of each Framework Section and the philosophy for its use. This was followed by the viewing of a PC Storyboard of the CIM-OSA Project and a walkthrough discussion of the 38-step CIM-OSA Life Cycle approach.



Each of the 38 steps of the CIM-OSA Lifecycle was examined by the Task 4 Team at the Minnesota meeting, and the applicability of the IDEF methodology to support these steps was assessed. The IDEF method was mapped to the requirements, design, and implementation phases of the CIM-OSA life cycle steps. The assessment determined that IDEF partially or wholly supports more than 50% of the steps, as reflected in Figure 1-1.

CIM-OSA Phase	CIM-OSA Step	Support by IDEF	Not Supported by IDEF
Requirements	20	15	4 Behavior 1 Integration
Design	9	5	4 Resources
Implementation	9	N/A	

Figure 1-1 IDEF Coverage of CIM-OSA Lifecycle Steps

The results of the mapping exercise show a high degree of IDEF support for the requirements and design phases. Furthermore, a limited number of enhancements will significantly improve the opportunity to apply the methodology on a much broader basis.

## C.2 IDEF U.G.

The IDEF User Group provided an important second source of methodology assessment input. It is the only group comprised entirely of IDEF-interest organizations, including users, tool vendors, and consultants. It therefore provides a key source of application needs and experience with the IDEF methods for the Task 4 assessment effort.

A meeting of the IDEF User Group was held during the Task 4 period of performance. The Task 4 Team took advantage of this opportunity to survey the attendees at the conference regarding their IDEF needs and recommendations. A special evening session was held during the meeting; about 30 participants from different organizations attended the session. The session resulted in several specific recommendations, which have been incorporated into the Task 4 Strategic Plan.

## C.3 Needs of the CALS Community

The Task 4 Team also assessed the needs of the Computer Aided Acquisition and Logistic Support (CALS) community as a source of important future IDEF support needs. In a meeting at the DoD CALS Office, it was recommended that the major need from the CALS perspective is to ensure compatability with the EXPRESS language.

Since CALS relies upon both IDEF1x and EXPRESS, and since there is significant overlap in capabilities, the CALS community would be best served by establishing integration links between IDEF1x and EXPRESS to reduce re-dundancy and to improve compatibility between the two modeling methods.

#### **C.4 Survey of User Needs**

The IDEF user community at large provided the Task 4 Team with the final major source of assessment input. To pursue this area, a survey of knowledgeable industry, academic, and Government individuals was conducted to determine their present analysis methods needs, their vision of their future needs, and the "lessons learned" from IDEF usage to date. The survey is a critical factor in identifying real needs.

The survey format closely followed the format used in performing industrial sector assessments. Appendix A presents the survey process, the questions asked, the names of the organizations surveyed (the Source List), and the responses.

#### **D. Assessment and Recommendations**

The Task 4 Team assessed the inputs from the above and other sources to identify and define key issues associated with methodology enhancements and complementary supplements without jeopardizing the basic IDEF Methods for activity and information modeling. (These methods have proven to be extremely valuable in evolving a total enterprise framework in the context of a single system.)

As a result of the assessment, a set of recommendations was developed with primary focus on a global framework, specifically CIM-OSA, with secondary focus on individual enterprise levels of application. The recommendations will be needed in the near future to keep the IDEF methods viable and the "method of choice" of Framework and Architecture developers and users (CIM-OSA, SEMATECH, CALS, etc.). The individual recommendations and the kinds of benefits provided by each, are presented below.

	<b>Recommendation</b>	<b>Benefits</b>
1	Integrate the ICAM-developed System Development Methodology (SDM) and the IDEF-UG-developed IDEF Framework with the IDEF Suite of Methods.	Reduce modeling cost/time Broaden application
2	Enrich the IDEF Methods such that models can be executable during requirements and design.	Improve model utility Increase ROI due to latent capabilities
3	Construct IDEF1x models of key CIM-OSA templates to support the application of IDEF on a global basis with a structured focus.	Strengthen Framework role Provide structured focus

4	Establish the integration links for IDEF0 and IDEF1/1x methods to allow the development of activity and information models that are integratable.	Encourage users More cost-effective IDEF use
5	Establish procedures, concepts, and tools that will sustain IDEF Enterprise models as reusable, with a method for implementing configuration management.	Reduce modeling cost/time≥ Leverage insight from existing models
6	Supplement the existing IDEF methods with syntax that will extend IDEF models to support design-level development.	Expand IDEF application area Increase IDEF utility for AF Operations
7	Extend IDEF0 and IDEF1/1x for expanded usability. Current descriptions of the IDEF Method lack insight for multiple applications such as: TQM, concurrent engineering, cost benefits, needs and requirements integration, and a host of related beneficial applications.	Achieve more useful models Leverage insight from modeling experience
8	Add IDEF0, IDEF1/1x Rule Sets for addressing behavioral issues. This was a key area of need associated with Frameworks on the level represented by the CIM-OSA concept.	Provide a structured Framework role Increase IDEF ROI
9	Add IDEF0 and IDEF1/1x Method Rule Sets to assure proper development and application of IDEF Methods.	Leverage modeling experience Reduce wasted modeling costs Expand industry receptivity to IDEF
10	Establish integration links for IDEF1/1x and EXPRESS so that both techniques can be used in a complimentary fashion.	Support CALS/PDES Reduce redundant effort
11	Provide standards and guidelines for the use and application of IDEF. This is a major void in the current method description that leads to mis-application, bad results, and bad press.	Increase usage benefits Reduce redundant and wasted efforts

The Task 4 Strategic Plan, Section 4, contains expanded detail for each recommendation. This is accompanied by a simple, systematic road map that provides an incremental development structure to allow for optimized and flexible implementation of improvements with acceptable returns on related investments.

## SECTION 2

### INDUSTRY DIRECTIONS

To achieve the required level of CIM capabilities for the U.S. and other countries to remain competitive, industry lines must be crossed and technology must be transferred and shared. Both Japanese and European industrial communities have initiated frameworks, methods, and technologies to make use of the available CIM capabilities in the most effective and efficient ways. The U.S. seems to have lagged behind in this endeavor, and must pull the industrial forces within the country together in order for all to remain competitive.

#### **A. Frameworks**

Major obstacles exist in the enterprise environment that are causing less than an optimum performance in the areas of information cost and information handling. The generation, management, and control of information and technology associated with product development, use, and servicing has evolved as a critical element in the development of integrated production systems. With the application of the computer in the production environment, new and costly complexities have surfaced regarding control and integration of information at different enterprise locations through the product development and product deployment phases.

The same issues have surfaced in both the Japanese and European industrial communities and both have major initiatives underway to address this problem. The U. S. is considered to be lagging in an equivalent effort. The issues that must be addressed to make integrated systems happen within the U. S. consist of; 1) establishing an enterprise integration framework (EIF), 2) achieving a national consensus to promote and establish the framework for a broad community of industries, and 3) developing common methods, standards, and specifications that will allow systems, based on a consensus architecture and method, to be integratable.

Under the EIF Program, the various frameworks currently under development were categorized in a helpful way. The categories are summarized in Figure 2-1, along with an example of a currently active framework effort for each category.

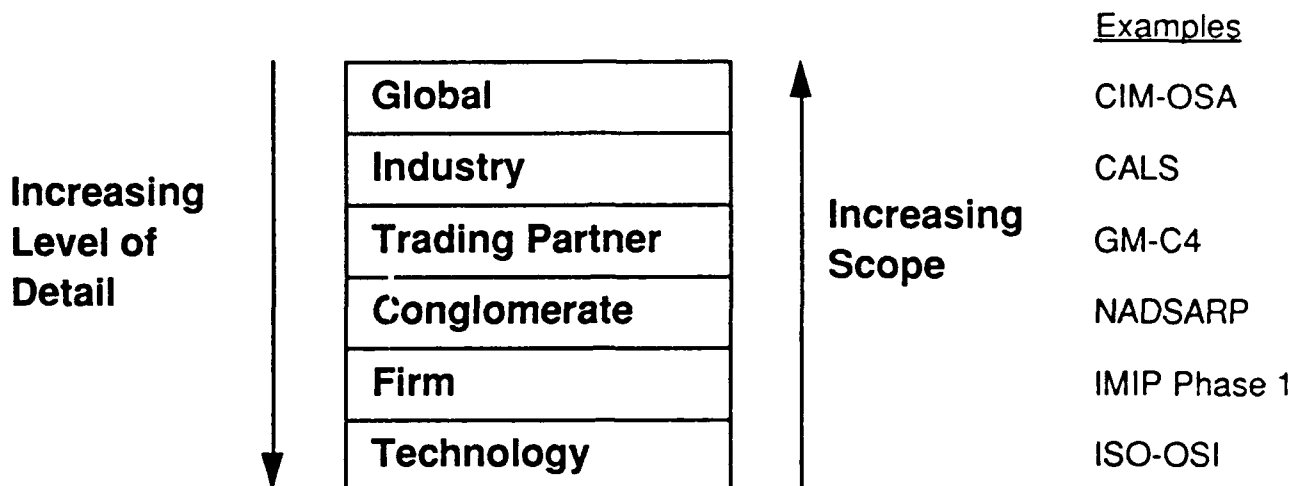


Figure 2-1 Categories of Frameworks (EIF)

Figure 2-1 shows that the CIM-OSA Framework has the largest scope, covering multi-industries, conglomerates of firms, and several technologies. Because of this broad scope, the EIF Program stated that the CIM-OSA Framework has the potential to be the "backbone" toward which they recommend future efforts be directed.

## B. Methods

The methods addressed in the Task 4 effort were mainly the IDEF and CIM-OSA activity and information modeling methods. Other periphery or complimentary methods and/or tools were addressed in the assessment but did not receive the detailed analysis that IDEF and CIM-OSA received.

Japanese framework initiatives are being developed to improve data integration within Japanese-owned companies located throughout the world. Very little information has been released about the Japanese developments currently underway. While conducting the DoD Assessment of Japanese Manufacturing Technology<sup>1</sup>, it was observed that most Japanese companies address enterprise integration on a cell level within the typical plant hierarchy (plant, center, cell, station, process).

While studying the operations of two of the companies visited, it was noted that IDEF activity and information models were being employed for analysis of future developments on a multi-plant level of world-wide operations. One enterprise presented a ten year multi-facility strategy as a single set of integrated systems. This

<sup>1</sup>Ref: Findings of the U.S. Department of Defense Technology Assessment Team on Japanese Manufacturing Technology, Final Report, June 1989.

represented a broad framework concept with methodologies, including IDEF, to support the analysis and development for enterprise integrated information systems. Detailed information on the IDEF application or the framework strategy was not made available by the Japanese company. This point emphasizes that other framework-like initiatives, using IDEF Methods, are being employed by U.S. competitors.

The European Strategic Programme for Research and Development of Information Technology (ESPRIT) is leading the development of activity and information modeling and simulation methodologies through the European Computer Integrated Manufacturing Architecture (AMICE) program -- a consortium of 21 companies from 7 European countries. The AMICE project, Computer Integrated Manufacturing - Open System Architecture (CIM-OSA), is a method that is based upon templates and living models developed to assure an Open System Architecture approach to CIM.

In the U.S., the EIF Program has recommended the adoption of the CIM-OSA Framework as a baseline. This step will ensure a common frame of reference and facilitate communications and joint development. Steps are already under way to formalize an agreement between the CIM-OSA organization and the MANTECH office of the Air Force.

From the surveys returned under the Assessment effort, U.S. industry has expressed the opinion that the future will see methods applied at the enterprise level, whereas they see present methods being used in a more limited scope. They have asked that methods be expanded to cover the enterprise level, wherever necessary, and that care be taken to see that methods are carefully integrated.

They anticipate an integrated set of methods and tools that can be applied to understand, model, and control enterprises. Enterprise analysis methods and tools will provide a means of analyzing performance through various forms of simulation. Standard frameworks will be used to identify when, how, and for what purpose these new methods should be properly applied.

"Object-Oriented" thinking appears to be anticipated as the new way of thinking about systems, according to the survey results. Therefore, whatever methods extensions are developed should take this influence into account so as not to become outmoded.

### **C. Technologies**

The technology currently supporting the use of IDEF is designed to support both textual and graphic input of diagrams and to check for consistency and syntax errors. Model structures can be retained and manipulated, and support for the Reader/Author critique of diagrams is available. About a dozen COTS (Commercial Off-the-Shelf) tools are available in the U.S. and Europe.

In general, integration between various IDEF methods is not supported. Each IDEF method is independent of the others, and data from one IDEF method must be manually extracted and input to another IDEF method. Data dictionaries have been successfully integrated with the IDEF methods and this feature is readily available in the support toolset.

Computer-Aided Software Engineering (CASE) technology has expanding and will soon include the Requirements Analysis level. One vendor of CASE tools has already included SADT as an optional tool in the CASE toolset. However, most CASE technology vendors appear to be ready to develop new methods for Requirements Analysis. This is either due to lack of readily available information and publicity on IDEF (most are unaware of its existence and potential), or it stems from a feeling that more elaborate syntax with additional computer-oriented constructs are needed to capture the fine detail of the requirements. In the latter instance, CASE technology is focused more on the Design Requirements of the software, whereas IDEF is focused on the earlier, System-Level requirements.

At the System Requirements level, communications between users and developers are key, and therefore favors the IDEF methods. At the Software Requirements level, just prior to the Design phase, the key is fine definition and traceability of detailed software requirements information. The future hope for the "marriage" of the two levels of requirements lies in a focused effort to define the interfaces and develop tools that export/import the information between the two levels.

The "Object-Oriented" approach is a technology that is gaining favor world-wide, and must be taken into consideration as it will affect IDEF. The survey of users clearly indicated that they expect the future of methods to lie in the "Object-Oriented" way of thinking. At this time, the "Object-Oriented" technology appears to be part of the Computer Science domain, and therefore is not perceived to be germane to the System Requirements domain of IDEF. However, any future extensions of IDEF methods must take this new technology into account and plan for the interfaces between IDEF and the new "Object-Oriented" requirements and design technology approaches as they become more popular and widespread.

Local Area Network (LAN) technology is another factor in the future considerations for IDEF. The use of LAN networks of small and medium sized computers with intelligent workstations has been gaining favor over the large mainframe/terminal approach. The IDEF tool vendors appeared after this evolution had begun, and are solidly aligned with the LAN technology side of the computer industry.

There are numerous modeling packages that have been used for IDEF methodology graphical and textual modeling. Many of these packages were developed specifically for IDEF modeling, while others were developed as methodology independent packages but can be used for various IDEF methodology modeling functions. Each of these tools

has been developed with a different interpretation of what an IDEF model consists of and the rules for creating and manipulating model elements, due to the lack of a clear and precise description of the IDEF methods. In general, those modeling packages developed by workers who were involved with the original development of the IDEF methodologies tend to follow the original intent more closely than those packages developed by less experienced IDEF practitioners.

Listed below is a representative sample, in alphabetical order, of the many automated modeling packages available for IDEF modeling. A one to two sentence description accompanies each identified package, indicating its uses and/or attributes.

- AIO, by Knowledge Based Systems  
This is an interactive, textual-input (as opposed to graphical input) PC-based tool for structured analysis, using hierarchical function modeling based upon IDEF0.
- AI2, by Knowledge Based Systems  
This is an integrated PC-based toolset for information analysis, that incorporates the IDEF0, 1, and 1x methodologies.
- AutoFAS, by Bernier & Associates  
This tool offers capabilities for generation of IDEF0 and IDEF1 models, simulation, organizational impact analysis, financial impact assessment, prioritization of needs, and related graphical and textual documentation.
- AUTOSADT, by Triune Systems  
This tool offers graphic diagram drawing and model retention for the SADT superset of IDEF0. It operates on the Macintosh platform.
- CBAM, by Control Data Corporation  
This tool uses the models developed in IDEF0 to allow for cross-function cost analysis.
- COINS, by Eclectic Solutions  
This tool is a PC-based graphical IDEF0 tool with data dictionary, that supports Kit processing and diagram/model manipulation features. VAX and other platform versions are also available.
- DAFNE, by Italsiel  
This a PC-oriented CASE tool with the SADT superset of IDEF0 integrated with the toolset provided by the Excellerator product of Index Technology. It features full database modeling capability, report generation, model



manipulation, etc. Support is available in Europe only.

- DEFIN.IT, by Solion Systems  
This tool is methodology-independent, but has the capability to support IDEF1 modeling. It uses ORACLE database support, and has graphical and textual capabilities.
- DEFT/DFD and DEFT/ERD, by DEFT  
This CASE tool runs on numerous platforms and is methodology independent. The graphical and report formats can be used to model and to analyze models created using the IDEF1x methodology.
- Design/IDEF (for PC and Macintosh), by MetaSoftware  
This tool is IDEF0 and IDEF1 specific. It offers text and graphic modeling capabilities in support of the IDEF methodologies.
- Design/CPN, by MetaSoftware  
This tool uses the Colored Petri Nets converted from Design/IDEF to simulate the model (s).
- The Developer, by ASIST Technologies  
This is PC-based tool for information modeling. It is a CASE tool that is methodology independent, but is customizable through the use of The Customizer.
- ERWIN, by Logicworks  
An IDEF1x tool for the IBM-PC, for conceptual modeling and database design. Uses Windows 3.0 in a graphical environment as well as SQL generation.
- FLEXIS, by Savoir  
This is a CASE tool and is not IDEF specific, and does not follow the IDEF rules. It can be used for simulation.
- IDEF/LEVERAGE, by DACOM  
This is a mainframe-based tool that supports both IDEF0 and IDEF1x activity and data modeling. It offers merge capabilities to create a composite model and transforms the DBMS model into SQL statements to assist in implementation. IDEF methodology reports are available.
- Personal IDEF/LEVERAGE, by DACOM  
This tool is similar to IDEF/LEVERAGE but is PC based and does not have the merge capabilities.

It is specific for single model development and for import into IDEF/LEVERAGE for analysis.

- IDEFine-0, by Wizdom Systems  
This package runs on PC or SUN platforms. It offers both IDEF0 textual and graphical modeling capabilities with the associated report generation capabilities.
- IDEFine-1x, by Wizdom Systems  
This package runs on PC (MS/DOS) or SUN (UNIX) platforms. It offers both IDEF1x textual and graphical modeling capabilities with the associated report generation capabilities.
- IDEFCost, by Wizdom Systems  
This tool uses the models developed in IDEFine-0 to allow for cross-function cost analysis
- IDEFGlossary, by Wizdom Systems  
This is the Glossary function in support of the IDEFine-0 and IDEFine-1 automated IDEF toolset.
- The Integrator, by ASYST Technologies  
This tool is a storage and display tool for information related to information systems development objects.
- ModelPro, by DACOM  
This tool is Microsoft Windows-based and is DACOM's IDEF methodology modeling graphics package. The tool offers two-way communication with IDEF/LEVERAGE for graphical representation and model creation prior to or after normalization, integration, and/or analysis.
- RETA, by SofTech  
A requirements evaluation, traceability, and analysis tool for use with a set of completed IDEF0 and IDEF1x models. Links requirements between IDEF0 and IDEF1x models and supports on-line analysis of the effects of system changes.
- Software Backplane, by Atherton Technology  
This tool is a CASE tool and is not IDEF specific. It supports the integration of various modeling methodologies, both function and information models, and allows for modification of report format.

There are numerous CASE tools that, with or without modification, can be used to automate the modeling required by the IDEF methodologies. The extent of their usefulness to IDEF modeling

relies on the users and modelers knowledge of the IDEF methodologies' rules and requirements.

### SECTION 3

#### ASSESSMENT MISSION

The mission of the Task 4 team "Assessment" effort is shown in Figure 3-1.

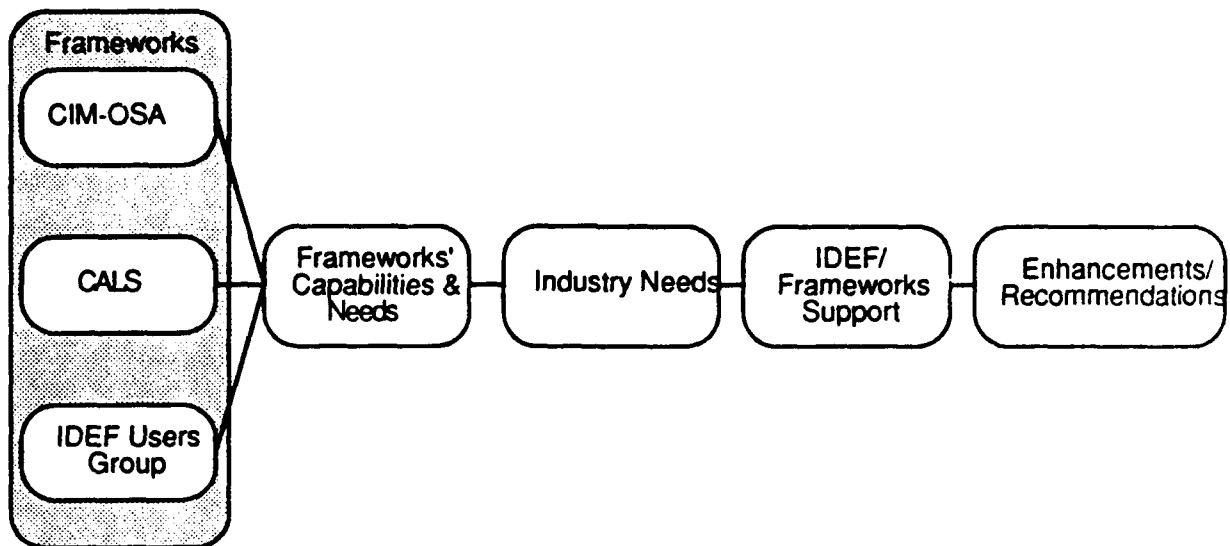


Figure 3-1 The Assessment Mission

The various active framework initiatives form the basis of the assessment process. Driven by these framework efforts, the required capabilities that enable IDEF to support the framework are assessed. Along with industry needs in general, as solicited from the industrial user community, the IDEF Framework and user support picture are defined. The required enhancements and recommendations to enable IDEF to achieve its potential in support of these needs and to ensure the IDEF legacy, are then defined as the output of the assessment task.

The Assessment Mission scope of effort is derived from the Integration Technology Division's (ITD) mission statement, however it is narrower in scope. By stating the Assessment Mission as a subset of the ITD mission, we see how it falls naturally within the domain of the ITD.

In the following Assessment Mission statement, the original ITD statement is presented, with wording changes included within "{}" braces, to indicate where the narrowing of scope is invoked to match the mission to the Assessment effort of the Task 4 team.

*The (Methods Assessment Project of the) Integration Technology Division (ITD) will provide an (assessment of the present status and recommendations regarding an) Air Force focus for the*

articulation, development, and implementation of processes, methodologies, and standards for information and technology integration across the entire product life cycle. (The Assessment Project will recommend a strategic plan with which) ITD will facilitate the transition of life-cycle requirements into the design and manufacture of weapons systems resultant in (1) reduced life-cycle costs, (2) reduced concept-to-deployment time, (3) improved product quality, and (4) increased Defense Industrial Base production and support flexibility. In addition, (the Assessment Project of) ITD is responsible for (recommending) applied research to advance the state-of-the-art for integration technologies and to expedite the transition of those component technologies to the Air Force Logistics Centers, the Defense Industrial Base, and other Air Force organizations.

To summarize, the Assessment Mission is to assess the present state-of-the-art in information and technology integration, and to recommend steps to facilitate transition of these integration approaches into the design and manufacture of weapons systems to reduce costs, reduce concept-to-deployment time, improve quality, and improve flexibility. The Assessment Mission results will also include recommendations for applied research toward these ends.

## SECTION 4

### STRATEGIC PLAN

#### A. Assessment Results

The information-gathering phase of the Task 4 effort resulted in a list of needs for IDEF methodology enhancements. To translate the needs into solutions to those needs, a Strategic Plan was developed by the Task 4 Team, using the Assessment Mission to guide the plan development. This section presents the Strategic Plan, beginning with the process of deriving specific recommended future tasks from the list of needs, and then laying out those tasks in the form of a roadmap for carrying them out.

Figure 4-1 summarizes the problems identified from the frameworks, surveys, and IDEF User Group sources, translates each problem into a set of needs, requirements, tools and methods involved, and lists solutions. Section B, below, translates these solutions into the specific task recommendations needed to achieve the desired solutions.

	Problems	Needs	Req'ments	Tools/Meth	Solutions
<b>Frameworks</b>	Lack of handling req'd aspects Mgt control use lacking Lifecycle usage missing	Extensions to methods Better model manipulation Usage guidance	Behavior & re-source handling CM and Simulation Info Add a Lifecycle procedure	IDEF0, IDEF1x  IDEF0, IDEF1x, IDEF2 (SLAM,TESS) IDEF0, 1x	IDEF0 extension task Lifecycle, frame, simulation task Incorp SDM into IDEF
<b>Surveys</b>	Mult Info Model methods Can't express relationships Must switch to other methods Ent'prise needs not covered	Add missing elements New syntax & semantics Extension to broader scope Add modeling capability	Extend IDEF1x for add'l capabil Inheritance, migration, etc. Extend methods for add'l areas Dynamics, behavior, cost	IDEF1x  IDEF1x IDEF0, 1x IDEF0	IDEF1x/EXPRESS task IDEF1x extension task Design syntax, CIM-OSA tasks IDEF0 extension task
<b>User Group</b>	Model inaccuracies. Lack of control of training/use Costly & slow model startup	Add'l required processing Evaluation approach Better use of prior modeling	Error, consistency checks Measures of good/bad use Reuse and Config Management	IDEF0, 1x  User Group Library Reuse, CM facility	Formal 0/1x integration Rule Sets, Stds & Guides task Reuse & CM task

Figure 4-1. General Matrix Mapping of Problems to Solutions

## **B. Recommendations**

The right-most column of Figure 4-1 shows the Recommendations designed to address each Problem identified in the left-most column. There are eleven recommendations in all resulting from the Assessment effort. In the remainder of this section, each of the eleven recommendations is presented in more detail.

### **B.1 Presentation Format and Content**

Eleven specific recommendations have resulted from the Task 4 findings. These are presented below in order of recognition, followed by a prioritization matrix and a suggested Roadmap for taking action to implement each recommendation.

Each of the eleven recommendations is presented in the form of a Presentation Slide, followed by further textual detail. Each slide has the same format, as shown in Figure 4-2.

RECOMMENDATION NUMBER ([number])	
[Name of the Recommendation]	
PRIORITY:	[1, 2, or 3]
NEEDS ADDRESSED:	[Needs identified during survey]
BENEFITS TO THE AIR FORCE:	[Why the Air Force should support the recommended effort]
INVESTMENT STRATEGY:	[Recommended support]
WHAT Should be Done:	[The goals and objectives]
HOW It Should be Done:	[Specific recommended steps]
OUTPUTS:	[Results produced (documents, software, etc.)]

Figure 4-2. Presentation Format for Recommendations

The goal of using this stylized presentation format is to ensure coverage of the key issues associated with each recommendation, and to facilitate understanding by the audience.

## B.2 Specific Recommendations

In this section, each of the eleven recommendations is presented in the format described in Section B.1.

RECOMMENDATION NUMBER (1)	
INTEGRATE ICAM/SDM AND FRAMEWORK INTO THE IDEF SUITE	
PRIORITY:	1. Prerequisite
NEEDS ADDRESSED:	(a) Provide Guidance in the Use of IDEF (b) Relate Methods Use to Frameworks (c) Establish Full Lifecycle Role for IDEF
BENEFITS TO THE AIR FORCE:	(a) Reduce IDEF Modeling Cost and Time (b) Expand Opportunity for Additional Benefits and Broader Applications
INVESTMENT STRATEGY:	Support Funded Co-Development with IDEF User Group
WHAT Should be Done:	Adopt standard Lifecycle definitions and flow descriptions for best established uses of IDEF within the SDM Guidelines. Include Lifecycle phase and step training in standard IDEF courses. Complete the IDEF Framework. Then use Lifecycle definitions and flow descriptions to identify Framework links to methods, and relate Framework cell interfaces via Lifecycle usage details.
HOW It Should be Done:	Merge SDM, Framework, and IDEF into a common specification. Use the IDEF User Group as a forum to gain consensus, to adopt standard Lifecycles, and to document the Lifecycle role of IDEF in standard training courses and manuals. Gather sample models and usage scenarios relating to individual Lifecycles, to provide guidance to IDEF users.
OUTPUTS:	(1) Combined SDM & IDEF Spec; (2) Sample Model and Usage Scenario Doc; (3) Executive Overview & Brochures

Figure 4-2.1 Recommendation "1"



RECOMMENDATION NUMBER (2)

ENRICH IDEF MODELS TO BE EXECUTABLE

PRIORITY: 3. Required

NEEDS ADDRESSED: (a) Support for Frameworks such as CIM-OSA  
(b) Extend Usability to Better Support  
Implementation Efforts

BENEFITS TO THE AIR FORCE: (a) Improve IDEF Utility  
(b) Greater Return on IDEF Investment  
due to Latent Capabilities

INVESTMENT STRATEGY: Fund Development of IDEF Execution  
Constructs that Supplement the Existing  
IDEF Specification

WHAT Should be Done:

Provide the IDEF Language enhancements and procedures necessary to allow IDEF models to become "executable specifications", especially at the Design Level. Provide the ability to understand AS-IS and test alternative TO-BE scenarios to evaluate design alternatives and tradeoffs. Relate the IDEF modeling and simulation bodies of knowledge.

HOW It Should be Done: (Related to Recommendations 4, 6, and 8)

In conjunction with 4, 6, and 8, analyze existing IDEF methods and tools, and develop supplemental specifications to: 1) add constructs necessary for simulation, 2) specify kinds and properties of simulations, 3) define outputs of simulation activities, and 4) map to existing simulation tools. Present features to the IDEF User Group and get consensus.

OUTPUTS: (1) Addendum to the IDEF Spec; (2) Prototype  
(3) Machine Executable Example

Figure 4-2.2 Recommendation "2"

RECOMMENDATION NUMBER (3)

CONSTRUCT IDEF1X MODELS OF CIM-OSA TEMPLATES AND IDEF CONSTRUCTS

PRIORITY: 2. Critical

NEEDS ADDRESSED: (a) Permit Communication w/CIM-OSA  
(b) Illustrate IDEF1x Utility to CIM-OSA  
(c) Provide Focused Areas for IDEF Applications

BENEFITS TO THE AIR FORCE: (a) Establishes Stronger Role and  
Attraction to IDEF for  
Framework Applications  
(b) Provides a Structured Focus

INVESTMENT STRATEGY: Support a Joint IDEF/CIM-OSA Effort

WHAT Should be Done:

Get templates of constructs from CIM-OSA and define the elements of each template and the relationships between the templates, using the IDEF1x method. Develop a meta-model of the IDEF constructs.

HOW It Should be Done:

Finalize the agreement of cooperation between the ManTech Office and CIM-OSA, and then organize a joint project in which an IDEF1x expert works with a CIM-OSA expert to define a model of the templates as well as a meta-model of IDEF constructs. Extend the meta-model as other recommendations extend IDEF modeling techniques. Distribute the resulting models and gain IDEF User Group consensus.

OUTPUTS: (1) IDEF1x Model of CIM-OSA Templates and meta-model of IDEF constructs; (2) Set of detailed technical recommendations for improvements to both IDEFs.

Figure 4-2.3 Recommendation "3"

RECOMMENDATION NUMBER (4)

INTEGRATE IDEF0 AND IDEF1X

PRIORITY: 2. Critical

NEEDS ADDRESSED: (a) Reduce Redundant Data Collection, Effort;  
Enhance Accuracy, Completeness, Consistency, Uniformity  
(b) Long-Standing User Group Request  
(c) Provide Single Model Relationship for  
Function and Info

BENEFITS TO THE AIR FORCE: (a) Encourage IDEF Use by Demonstrating Support for Requests from Users  
(b) More Cost-Effective IDEF Usage

INVESTMENT STRATEGY: Fund an Integration Methods & Spec Development Contract with Academic, Practitioner, Framework, User, and Vendor Technical Input

WHAT Should be Done:

Develop an Integration Approach and set of corresponding specifications for the IDEF0 and IDEF1x methods. The approach must: 1) allow integration at both the requirements and design levels, 2) permit IDEF0 and IDEF1x models to be developed in any order, including concurrently, and 3) include how to integrate, which completeness and consistency checks to make, and how to use these checks. Continued use of IDEF as in the past must be permitted.

HOW It Should be Done:

Contract with a company or coalition with demonstrated IDEF0 and IDEF1x credentials to develop the method, including graphics syntax, semantics, and pragmatics, to provide the needed integration of the content of both models. Use the experience of the users and Tool Vendors to provide, as a minimum, the benefits demonstrated on past modeling efforts which related IDEF0 and IDEF1x by such techniques as data dictionaries.

OUTPUTS: (1) Addendum to the IDEF Spec document; (2) Meta-model of IDEF0, IDEF1x, and the Integration Constructs

Figure 4-2.4 Recommendation "4"

RECOMMENDATION NUMBER (5)

ADD CONCEPTS & TOOLS FOR REUSE & CONFIGURATION MANAGEMENT

PRIORITY: 3. Required

NEEDS ADDRESSED: (a) Permit "Living Model" Use of IDEF  
Rather than One-Shot Analysis  
(b) Facilitate New Model Startup  
(c) Establish Maintenance & Update as an  
On-going Process

BENEFITS TO THE AIR FORCE: (a) Reduce Modeling Cost and Time  
(b) Leverage Insight from Existing  
Models

INVESTMENT STRATEGY: Support a Funded Co-Development with the  
IDEF User Group

WHAT Should be Done:

Use existing body of reusability research and configuration management knowhow to adopt IDEF standards for both capabilities. Encourage tool vendors to comply with these standards. Develop a meta-model based on the IDEF Framework which includes configuration definition, model check-out/check-in, change notification, design intent capture, and usage cross-reference.

HOW It Should be Done:

Re-address Project 1104 procedures for maintenance & configuration control. Charter a Working Group of the IDEF User Group to investigate and select features from available commercial products. After adoption by the IDEF U.G., select a contractor to develop & implement the meta-model using an object-oriented DB management system and publish/demonstrate the results to the Air Force and the IDEF U.G. Establish a model reuse facility and solicit contributions.

OUTPUTS: (1) Requirements Spec; (2) Meta-model; (3) Prototype  
Reuse/CM System

Figure 4-2.5 Recommendation "5"

RECOMMENDATION NUMBER (6)

DEVELOP DESIGN-LEVEL SYNTAX

PRIORITY: 2. Critical

NEEDS ADDRESSED: (a) Provide Design Capabilities  
(b) Enhance Methods to Better Support Implementation

BENEFITS TO THE AIR FORCE: (a) Expand IDEF Application Areas  
(b) Increase Utility of IDEF for Air Force Operations

INVESTMENT STRATEGY: Fund Design Extension Effort

WHAT Should be Done:

IDEF Methods were originally intended to support understanding, needs, requirements, and benefits analysis. Addition of design syntax to the basic IDEF syntax should be made, to broaden the scope of applicability of IDEF and reduce the number of different methods that must be employed. Include representational power of data flow diagramming and external and internal schema, as a minimum capability.

HOW It Should be Done:

Contract with a methods development organization that is familiar with modern design methods to bring IDEF up to (and beyond) the capabilities of other methods or choice in the design area. Use the IDEF User Group as a "sounding board" to gain acceptability of features before implementation, run demos, etc. Define the design constructs as a superset of present IDEF so as to retain upward compatibility. Factor in CIM-OSA design level constructs when available.

OUTPUTS: (1) Addenda to the IDEF Specifications (both IDEF0 and IDEF1x)

Figure 4-2.6 Recommendation "6"

RECOMMENDATION NUMBER (7)

EXTEND IDEF0 AND IDEF1X FOR EXPANDED APPLICATION

PRIORITY: 2. Critical

NEEDS ADDRESSED: (a) Provide "Lessons Learned" Benefits from Usage Experience  
(b) Remove Present Usage Limitations

BENEFITS TO THE AIR FORCE: (a) Provide More Useful Models  
(b) Leverage Insight from Existing Modeling Experience

INVESTMENT STRATEGY: Fund an Initiative to Assess and Implement Complete Application Understanding

WHAT Should be Done:

Implement recommendations for features which have been found to be useful from experienced IDEF user organizations. Include features from rival methods so as to make IDEF the "method of choice".

HOW It Should be Done:

Request IDEF User Group members to write up and contribute selected enhancements. Re-visit the original SADT and Information Modeling methods to consider features that were originally excluded from IDEF, to see present applicability. Use the IDEF U.G. to determine acceptability. Evaluate capabilities added to rival methods since the adoption of IDEF, to see if similar enhancements should be made to IDEF. Develop  
a Guidelines document, and update courses and specs for adopted features.

OUTPUTS: (1) "Guidelines on Usability" Document; (2) Updated Specs and Course Material

Figure 4-2.7 Recommendation "7"

RECOMMENDATION NUMBER (8)

ADD IDEF0 AND IDEF1X RULE SETS FOR BEHAVIORAL ASPECTS

PRIORITY: 3. Required

NEEDS ADDRESSED: (a) Support for Frameworks such as CIM-OSA  
(b) Remove a Recognized IDEF Limitation

BENEFITS TO THE AIR FORCE: (a) Establish Stronger Role and  
Attraction to IDEF for Framework  
Applications  
(b) Greater Return on IDEF Investment

INVESTMENT STRATEGY: Fund a Requirements and Spec Effort

WHAT Should be Done:

Add rules for modeling and specification of behavioral aspects of an enterprise. Integrate the new capabilities with the modeling capability. Make a meta-model of the constructs, and match to capabilities of object oriented databases.

HOW It Should be Done:

Fund the development of a set of Templates of Constructs which model behavioral aspects of an enterprise. Relate the resulting method and develop examples of its use as support of the CIM-OSA lifecycle steps not now supported by IDEF. Add results to the IDEF specification, courses, repository of models, etc. Use the IDEF User Group to review and recommend changes to the new feature. Fund an optional prototype development effort.

OUTPUTS: (1) Meta-model of Constructs; (2) Addenda to Design-level Specs; (3) Prototype

Figure 4-2.8 Recommendation "8"

RECOMMENDATION NUMBER (9)

ADD IDEF0 & IDEF1X METHOD RULE SETS

PRIORITY: 3. Required

NEEDS ADDRESSED: (a) Provide "Lessons Learned" Benefits from Usage Experience  
(b) Control Proper Use of IDEF & Eliminate Negative Image Caused by Mis-application

BENEFITS TO THE AIR FORCE: (a) Leverage Good Modeling Experience  
(b) Reduce Wasted Modeling Costs  
(c) Expand Industry Receptivity to Use IDEF

INVESTMENT STRATEGY: Support Funded Co-Development with the IDEF User Group

WHAT Should be Done:

Develop Usage Rules from experienced users, to help guide IDEF training and usage. Incorporate usage rules into IDEF training courses and other materials. Publicize resulting rule sets so as to inhibit improper IDEF usage under the name of "IDEF".

HOW It Should be Done:

Establish a Working Group task under the IDEF User Group to develop the Rule Sets. Distribute the draft Rule Sets to the full User Group mailing list for comment and recommendation. Use the IDEF User Group forum to hold discussion and vote adoption.

OUTPUTS: (1) Method Rule Set Specifications

Figure 4-2.9 Recommendation "9"



RECOMMENDATION NUMBER (10)

PROVIDE IDEF1X AND "EXPRESS" INTEGRATION LINKS

PRIORITY: 3. Required

NEEDS ADDRESSED: (a) Eliminate Current Mismatch Problems  
(b) Extend Info Modeling Capability to IDEF1x  
(c) Establish IDEF as Complimentary with EXPRESS

BENEFITS TO THE AIR FORCE: (a) Support CALS/PDES Standardization  
(b) Reduce Redundant Efforts

INVESTMENT STRATEGY: Support Funded Co-Development with the IDEF User Group

WHAT Should be Done:

Analyze the process of common data exchange between IDEF1x and EXPRESS to determine the items which must be added or streamlined to improve joint use of IDEF and EXPRESS. Determine how to add these items to the IDEF1x models. Determine "loose" and "tight" linkage approaches. Coordinate with Recommendations 2, 6, and 8.

HOW It Should be Done:

Establish an IDEF-UG Working Group to study the problem and recommend enhanced IDEF1x syntax, semantics, and pragmatics to be added to the standard IDEF1x definition. Attain approval of the IDEF User Group, and contract with a methods consulting company or coalition to complete the design, documentation, training materials, etc.

OUTPUTS: (1) IDEF1x-to-EXPRESS Links; (2) Integration Methods Spec;  
(3) EXPRESS-to-IDEF1x Links

Figure 4-2.10 Recommendation "10"

RECOMMENDATION NUMBER (11)

PROVIDE IDEF STANDARDS AND GUIDELINES

PRIORITY: 11(a)            1. Prerequisite;            11(b)            3. Required

NEEDS ADDRESSED:            (a) Eliminate Misuse and Misunderstanding  
                              (b) Expand & Advertise IDEF Capabilities  
                              (c) Establish Baseline Standard  
                              (d) Provide Basis for Validation & Verification

BENEFITS TO THE AIR FORCE:            (a) Increase Benefits from IDEF Use  
   (b) Less Redundant & Wasted Effort

INVESTMENT STRATEGY:            Provide Funding for Updating the Users  
   Manual into a Standard

WHAT Should be Done:

Gather specs, procedures, concepts/purpose/goals statements, examples, training materials, papers, etc., to be used for guidance by novice IDEF users. Advertise the availability of this material and its use to show to potential new IDEF users. Use as guidance for new IDEF users to avoid improper usage of the methods. Split the effort into two tasks: Use initial spec as a baseline prior to other enhancements (Task 11(a)), and incorporate results of pursuing the other recommended tasks as a final repository (Task 11(b)).

HOW It Should be Done:

Instead of "Certification" of IDEF trainers and users, examples of good practice should be gathered, advertised, and used to guide application of the methods. The IDEF User Group must serve as the central repository of such material, as well as the focal point for publicity and the source of authorized IDEF Materials.

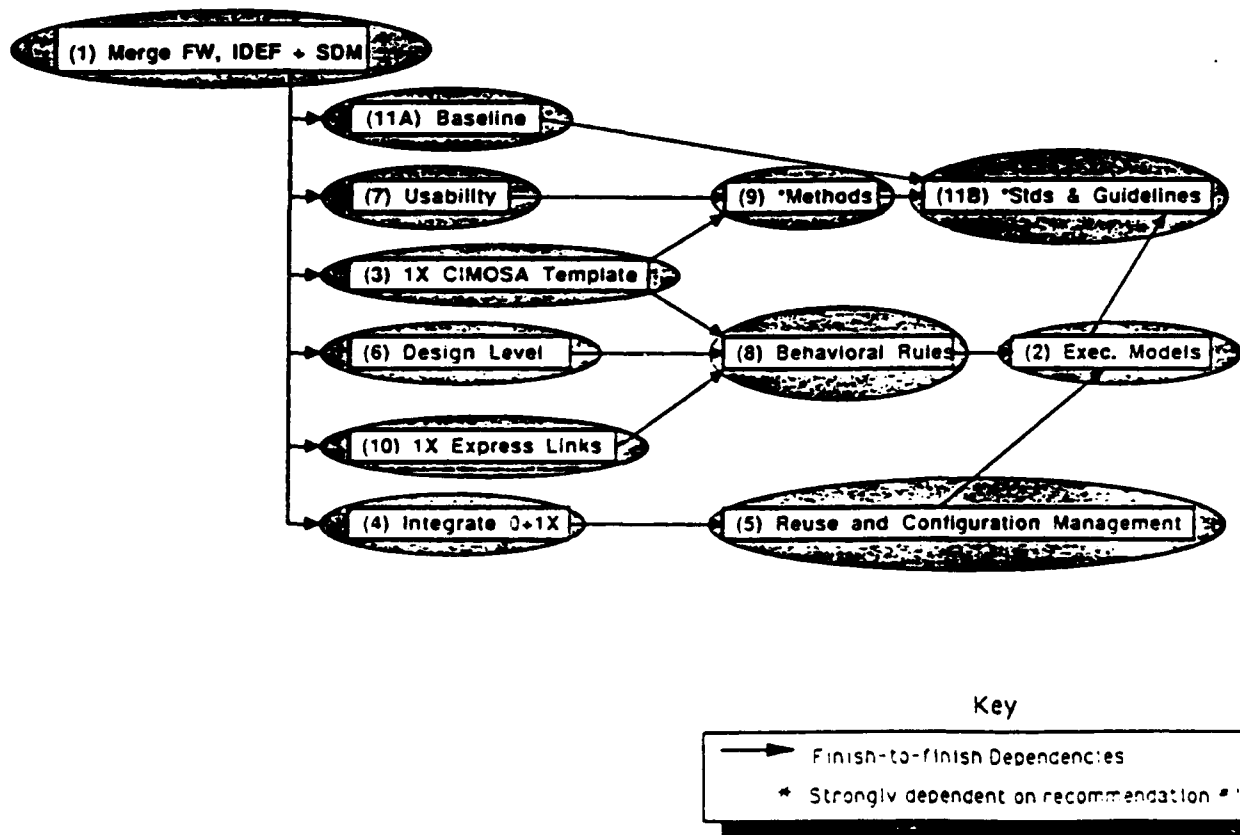
OUTPUTS:    (1) Critical Specs for Initial Baseline (11a);  
              (2) Final Specs (11b)

Figure 4-2.11 Recommendation "11"

### B.3 Prioritization of Recommendations

The eleven recommendations have been presented in order of recognition. There is a natural ordering between several of the recommendations, since in some cases the recommended activity uses the results of one of the other recommended activities. This "natural order", plus the invoking of a "criticality factor" provides a recommended sequence in which to pursue the recommendations.

Figure 4-3 shows the "natural ordering" of the recommendations with interdependencies illustrated by the finish-to-finish connections. Note that Recommendation 11 (IDEF Standards and Guidelines) is split into two tasks -- 11(a) "Baseline Standards and Guidelines" to provide the basic standards and guidelines needed to pursue the high-priority recommendations, and 11(b) "Enhanced Standards and Guidelines" to provide the remainder of the standards and guidelines developed as a result of pursuing the recommended tasks.



4-3 Natural Ordering of Recommendations

Figure 4-4 summarizes the "criticality factor" for each recommendation based upon the following 6 criteria:

- (a) Maintain IDEF as a viable tool of choice for generic frameworks
- (b) Establish interfaces to make IDEF complimentary for use with other framework tools
- (c) Extend utility of IDEF to cover broadest scope framework
- (d) Acceptability of enhancements by IDEF User Group
- (e) Make use of and interface with emerging technologies
- (f) Cornerstone prerequisite (required as a basis for other recommendations)

In each case, the Task 4 team ranked each of the eleven recommendations as a 1, 2, or 3 (highest) based upon each criterion. Figure 4-4 summarizes the resulting ranking. Each recommendation achieved a ranking of between 10 and 15. The priority was then assigned based upon a three-level prioritization scheme:

Top Priority:	"Prerequisite"	Ranking 15-16
Second Priority:	"Critical"	Ranking 13-14
Third Priority:	"Required"	Ranking 10-12

CRITICALITY FACTORS	RECOMMENDATIONS										
	1. Integrate IDEF SDW into the IDEF Suite	2. Enrich IDEF Models to be Executable	3. Construct IDEF's Model and IDEF's Templates	4. Integrate IDEF's Model and IDEF's Templates	5. Add Concepts & Tools for Re-Use and CA	6. Develop Design-Level Constructs	7. Extend IDEF for Usability Enhancements	8. Add IDEF Rule Sets for Behavioral Aspects	9. Add IDEF Rule Sets for Rule Sets	10. Provide IDEF's Method Integration Links	11. Provide IDEF Standards and Guidelines
A. Maintain IDEF as a viable tool of choice for G. Frameworks	2	3	2	2	3	3	1	2	2	2	3
B. Estab. interfaces to make IDEF complim. for use w/other Frame tools	3	1	3	2	2	2	1	2	1	3	3
C. Extend util of IDEF to cover broadest scope Framework	2	2	2	2	2	2	3	2	3	2	2
D. Acceptability of enhancements by IDEF User Group	3	1	2	3	2	3	3	2	3	1	3
E. Make use of & interface with emerging technologies	2	3	2	2	2	2	3	3	2	1	2
F. Cornerstone Prerequisite	3	1	2	2	1	2	2	1	1	1	3
SCORE:	15	11	13	13	12	14	13	12	12	10	16

Figure 4-4 Recommendation Ranking Matrix

### C. Suggested Roadmap

Using the prioritization resulting from the application of the six criteria, and taking into account the natural precedence of the eleven recommendations, a suggested Roadmap was developed (see Figure 4-5). The shaded areas at the beginning of several of the roadmap boxes represent possible "early start dates" for these tasks. That is, there is no logical reason that the effort cannot begin at the earliest date shown, except for availability of personnel and funding.

Across the top of Figure 4-5, a row of triangles numbered "P1" through "P5" are shown. These represent natural milestones in the timeline, when groups of efforts should be started or completed.

## Task #4 IDEF Enhancement Roadmap

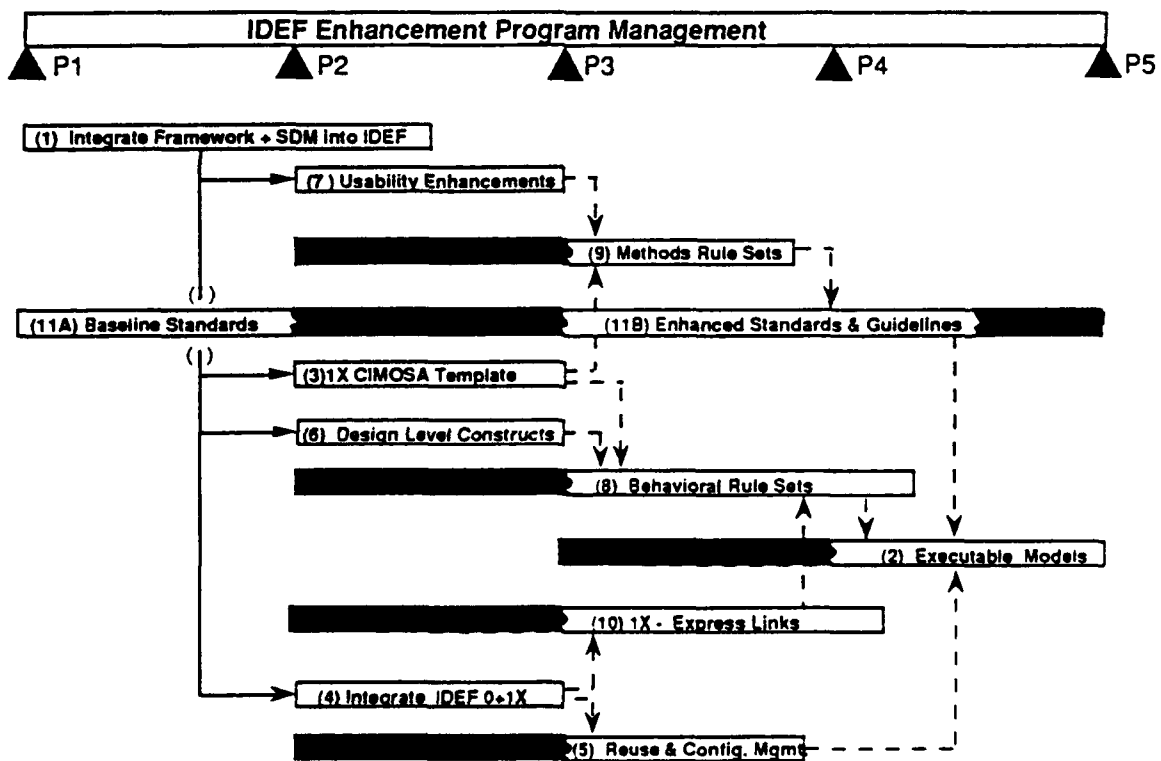


Figure 4-5 IDEF Enhancement Roadmap

## **SECTION 5**

### **SYNOPSIS OF ACCOMPLISHMENTS**

#### **A. IDEF User Group Meeting**

A semi-annual IDEF User Group meeting was held on May 22-24 at the Washington Plaza Hotel, Washington D. The Task 4 team took advantage of this opportunity by holding a special evening meeting on Wednesday, May 23 to solicit recommendations for IDEF enhancements by the User Group members. About 30 people attended.

The meeting began with an introduction to the Task 4 goals and objectives, followed by verbal recommendations from the floor. At the end, a call was made for any User Group member to submit his name and address to be added to be contacted at a later date. Fourteen names were submitted to the chairman. These names were later added to the Source List to receive a solicitation package.

The meeting was organized around four overhead slides, which presented an overview of Task 4, the specific Task 4 objectives, the planned format of the Strategic Plan to be developed, and a list of the potential contributions from the User Group attendees. The specific slides are included in Appendix B "Meeting Minutes".

The discussion resulted in several specific recommendations, which have been incorporated into the Strategic Plan in Section 4 "Submitted Recommendations", below. In general, the recommendations fell into two primary categories: 1) standardization/formalization needs, and 2) specific syntax/semantics needs. The lengthiest discussion topic was on training and experience standards for determining who is and is not to be labeled an "IDEF Expert", both for developing models and for training new authors.

#### **B. CIM-OSA Support Assessment**

The primary framework driving the assessment effort was CIM-OSA. Specific enhancements to IDEF have resulted from the team's investigation of the CIM-OSA needs.

Briefly, the Air Force is interested in having IDEF selected to support the CIM-OSA Framework and Lifecycle developments. The alternative would be to have CIM-OSA invest in new methods development which is incompatible with IDEF. This alternative would be costly to the companies supporting CIM-OSA, would lead to difficulties in understanding and using the results of CIM-OSA in the U.S., and would greatly reduce the value of the legacy and Air Force investment in IDEF models such as the ICAM Generic Model of Manufacturing.

The May IDEF User Group meeting afforded the opportunity to discuss potential cooperation between the IDEF community and the CIM-

OSA community. A representative of the CIM-OSA organization attended the IDEF User Group conference in Washington, and met with the IDEF Steering Committee the evening of Monday, May 22 to explore potential cooperation. As a result of this meeting, the Air Force sent a letter to CIM-OSA as a first step in arranging for cooperative technical efforts. The CIM-OSA representative also remarked that the technical papers presented at the conference were very enlightening and encouraging for potential IDEF use in his CIM-OSA work.

To better assess the potential for IDEF as a method for use by CIM-OSA, the Task 4 team requested that the Air Force arrange a technical interchange meeting with a representative CIM-OSA organization in the U.S. In response to this request, the Air Force contacted IBM, and arranged a two-day meeting in Rochester, Minnesota (see Executive Summary and Meeting Minutes in Appendix B.2, below). A representative from the IBM/Oswego facility also attended, since that facility is also participating in the CIM-OSA effort.

At the meeting, it was determined that there is significant potential for IDEF support of CIM-OSA. By going through the CIM-OSA Lifecycle at length, it was determined that the majority of the Lifecycle steps can be at least partially supported by IDEF. Specific IDEF enhancements were noted as a result of the technical assessment. However, several detailed technical questions remained that could not be answered by the Rochester/Owego IBM staff.

It was decided, as part of the new cooperation being arranged by the Air Force, that the Task 4 Group conduct an on-site visit to CIM-OSA at their European facility, to clarify these technical issues and to further pursue the IDEF support issues. Later, at the July 24 Task 4 meeting, word was received via the Air Force that CIM-OSA had decided not to permit the planned European visit.

CIM-OSA stated that this decision is not intended to convey lack of interest, but is a result of CIM-OSA concerns regarding proprietary disclosure of information funded by the CIM-OSA organizations. Further investigation of these issues is being pursued, and it is anticipated that the technical interchange meeting will take place at a later date, once the legalities, ground rules, and participating organization agreements are arranged.

## **C. Survey of Needs**

### **C.1 Source List and Assignments**

At the initial meeting, a "Source List" of 29 names and organizations to be contacted by the Task 4 group was developed. Later, the list was expanded to 41 names through submittals at the IDEF User Group meeting, and by the Task 4 team members.

The final list of Sources is included in Appendix A. The names on the list through 29 were contacted individually before being sent a solicitation letter and list of questions. The remaining names (30

through 41) had requested that they be added to the Source List; four of these were contacted individually by telephone, and the remainder received a mailing without prior telephone discussion, due to schedule limitations.

## **C.2 Cover Letter and Generic Question List**

The Task 4 team decided that a standard Cover Letter be developed for use with mailings to the Source List names. This letter was developed, reviewed and modified by the Air Force, and distributed to the Task 4 team members. A copy of this letter, along with the final set of generic questions is included in Appendix A.

Note that the "Generic Questions" are intended as a starting point and thought-provoker. People on the Sources List were told that they should feel free to add recommendations and needs not related to specific question list items, and not to bother answering questions that are not related to their individual IDEF usage experience.

## **C.3 Summary of Survey Results**

The results of the solicitation were very encouraging. Significant benefits are being achieved through the use of IDEF, and there is enthusiastic support for continued support and extension of the IDEF methods among the user community.

The recommended enhancements to IDEF resulting from the survey are compatible with the CIM-OSA findings; therefore, the Task 4 Team is confident that their recommendations are well-founded and backed by real industry needs.

## **D. Meetings**

There were four Task 4 Team Meetings over the contract's Period of Performance, as well as special presentations to the IDEF User Group Steering Committee and the IDEF User Group itself (special evening session):

- (1) Kickoff Organizational Meeting (May 16)
- (2) IDEF User Group Session (May 22-24)
- (3) Rochester CIM-OSA Meeting (June 20-22)
- (4) Working Session (July 23)
- (5) IDEF Steering Committee Presentation (Aug 21-22)
- (6) Final Working Session (Nov.13)

Minutes for each of these meetings are included in Appendix B, below.



## **E. Final Report, Including Recommendations**

The development of the Final Report was a cooperative effort by the Task 4 Team members, with each member contributing assigned sections. In addition to their assigned sections, each Task 4 Team Member submitted one or more 2-page recommendation items. The Final Working Session was used to finalize these important results.

## **F. Literature Review**

Although many activity and information modelers were contacted during the survey, a formal review of available literature on the applications of modeling efforts was deemed necessary. Because of the tremendous scope of modeling methods being used and the belief that IDEF is the most comprehensive structured approach, the team limited their review to literature discussing the application of the IDEF methods. The information obtained was integrated with survey data and meeting notes, and supports the recommendations presented in Section C.1.

Applicable IDEF articles and technical report references were found through an exhaustive literature database search. Their abstracts were then reviewed to identify pertinent materials. Through interlibrary loans and the Team's library archives, the identified articles were found and subsequently reviewed.

The review and assessment of the IDEF articles generated a list of both negative and positive issues as described by the authors. This list has been categorized below. The issues listed provide a high-level summarization of the major positive and negative points found in the literature search.

### **Positive:**

- (1) Supports many disciplines
- (2) Represents real user needs
- (3) Provides an integrated picture
- (4) Excludes political issues
- (5) Able to conceptualize the future
- (6) Provides a stable info structure
- (7) Catches redundancies, missing, organization processes
- (8) Results are structured

### **Negative:**

- (1) Unfamiliar, applied narrowly to Mantech
- (2) Not simulatable, lacks other language extensions
- (3) Costly and time-consuming
- (4) Lacks guidelines

With the exception of the unfamiliarity of the method and its perceived (but not warranted) restriction to the Mantech application arena, each of the four major objections from the literature is

addressed by at least one of the Recommendations in the Strategic Plan. The ability to use IDEF models as a basis for simulation, and the addition of other missing language constructs, are included in Recommendations 2 and 7. The cost and time-consuming nature of the modeling is greatly alleviated by several of the recommendations: Recommendation 1 (a lifecycle methodology), Recommendation 3 (templates to support standardized IDEF application), Recommendation 5 (reusable models and configuration control), Recommendation 9 (application Rule Sets), and Recommendation 11 (standards and guidelines), each contributes to reducing the cost and time required to develop models. The lack of proper guidelines for applying IDEF is addressed by Recommendation 11.

## **G. Summary**

The Task 4 Team began with the goal of assessing IDEF's activity and information modeling methods in light of needed support for enterprise framework applications. The CIM-OSA Framework and Lifecycle became the primary framework in the assessment, and an in-depth, 3-day technical session was held to explore specific CIM-OSA support issues with CIM-OSA experts. The IDEF User Group and a list of key organizations and individuals were also surveyed, as additional important sources of needs. Presentations of draft findings and recommendations were made at various times to the IDEF User Group Steering Committee as well as the User Group attendees at meetings.

The assessment resulted in a list of eleven recommendations for IDEF enhancements, with each member of the Task 4 team contributing to the list. These recommendations were then prioritized and incorporated into a Strategic Plan, including a roadmap and specific recommendations regarding: investment strategy, what should be done, how it should be pursued, and the form of the outputs for each effort in the roadmap. Section 4 of this report presents the Strategic Plan.

## **APPENDIX A**

### **SURVEY OF THE INDUSTRY**

#### **A.1 The Survey Procedure**

Once the scope of the survey was determined, a literature search was started for all recent articles on IDEF. While this was being performed, the Team developed a list of experts to whom a questionnaire would be sent to solicit information for the assessment. Once the list of experts and a generic list of questions was developed, reviewed, and approved, the survey was conducted.

To initiate the survey, each team member personally contacted a subset of the Source List, and discussed the questions. Once the telephone contact had been made, a cover letter and the formal list of questions was mailed out. When time became short, the cover letter and the set of questions was mailed without the telephone contact step.

The survey results identified and assisted in the definition of needs, requirements, and recommendations of activity and information modeling methods. Information was received on potential enhancements, lessons learned, and target opportunities for the use of activity and information modeling methods.

In the remainder of this section, the cover letter and questionnaire are reproduced, to document the survey material as distributed to the Source List.

#### **A.2 The Survey Questionnaire**

[Address of person to be visited]

Dear \_\_\_\_\_:

Thank you for agreeing to participate in our assessment of activity and information modeling methods. This letter is to provide additional background information on the project, and to provide a list of questions regarding analysis methods and frameworks of methods.

#### **BACKGROUND**

There is an Air-Force-sponsored study under way to identify and prioritize enhancements to the IDEF Methods (both activity and information modeling). The project is a 5-month team effort by SofTech, CDC, and BDM International.

This team is presently assembling information on potential enhancements. Once all sources of recommendations have been surveyed, the team will assess the results, prioritize the

recommendations, and present this material to both the IDEF User Group and the Air Force sponsors at WPAFB/WRDC/MTI.

The objectives are to

- (1) assess existing "Framework" initiatives such as CIM/OSA, and to identify requirements for improved IDEF support for these efforts
- (2) develop a "strategic focus" and a strategy for accomplishing the needed improvements
- (3) prioritize targets of opportunity
- (4) benefit from "lessons learned"
- (5) prepare the recommendations in the form of both a technical and a business strategy

The final result of the effort will be a Strategic Plan. This plan will include a "Vision Statement" which identifies perceived industry directions and general needs, lists specific needs, and presents specific recommendations, including a rationale and anticipated benefits resulting from each recommendation.

Our team is interested in your ideas and insights regarding Framework-driven IDEF requirements as well as any "lessons learned" from your experience using IDEF or other similar Enterprise Analysis methods. Any documents, presentations, or other hard-copy information you could provide that would help ensure correct understanding would also be appreciated. Also, if you have names of other points of contact for further insight, please provide a name and means of contacting them.

#### LIST OF QUESTIONS

The attached list of questions is for your consideration. We do not necessarily expect you to provide an answer to each of the questions; they are intended to cover the broad scope of our assessment, and each information source will find a subset of the questions of particular relevance to his experience with IDEF.

The list attempts to capture key issues of concern to the industry, but we anticipate that you may have specific issues to raise that may not be on the list. Please feel free to do so. Also, if other issues come up later, we would appreciate your writing or phoning in these further thoughts. Please send or FAX your response to:

[Point of Contact]  
SofTech, Inc.  
460 Totten Pond Road  
Waltham, MA 02154-1960

FAX: (617) 890-6055

We wish to make this effort as complete and responsive to real needs as possible, and we appreciate your assistance in this effort.

## GENERIC QUESTIONS TO ASK INFO SOURCES

### FRAMEWORK QUESTIONS:

- (a) How would you define the Purpose of your Framework?
- (b) Does your Framework effort include the specification of a specific methods Architecture, or are multiple methods accommodated?
- (c) Describe how you plan to use the Framework once it is complete and accepted. Can you give a scenario of an Enterprise improvement project which uses the methods referenced by your Framework?
- (d) Does your Framework have a formal definition (meta language)?
- (e) How are the individual cells in your Framework defined? How are methods analyzed and included in your Framework? Do you have a "uniqueness rule" regarding information fitting into a Framework cell?
- (f) How do you define inter-cell integration of information derived via application of methods?
- (g) Who is responsible for pursuing the completion of your Framework, and how is this effort done? What are plans for future modification and maintenance of your Framework?
- (h) How do you plan to publicize and gain acceptance for your Framework?
- (i) What are the restrictions on use of your Framework material?
- (j) What is the scope of your Framework? How does it apply to the analysis of all aspects of an "Enterprise"?
- (k) Do you wish to coordinate activities with the IDEF Framework effort? How?
- (l) May we have copies of the latest Framework document? May the IDEF User Group be placed on your mailing list for future document distribution?
- (la) What is the lifecycle approach/structure that drives your info and activity modeling procedure?
- (lb) How would you define an "Enterprise"?

#### METHODS QUESTIONS:

- (m) Types of models and methods used? Activity models?  
Information models?
- (n) What have you found to work well? What "voids" (methods applicability related to Framework requirements) have you found?
- (o) Given the opportunity to extend methods, what extensions would you make and what priority would you assign?
- (p) What training do you use for modelers? What training requirements do you follow? Do you "screen" candidate modelers? If so, how?
- (q) What "Structured Application" (lifecycle) procedure do you use to orient use of methods?
- (r) Where do you see your future methods requirements going? Where are currently used methods going? What evolution do you foresee?
- (s) Can you reference each method used to a definition or textbook? A person? Could you send any definition material of this nature to us?
- (t) What types of hardware and software tools do you use to support use of these methods?
- (u) Are verification and validation checks of models performed? What checks? How are they made?
- (v) How do you "package" your models? Can you give us an example?
- (w) What standards (e.g. PDES) have you considered and/or used?
- (x) Which groups and committees do you participate in? To what extent do you participate (e.g. conference attendance, participation in Working Groups, etc.)
- (y) What previous methods and/or Frameworks have you considered in your developments?
- (z) Do you have corporate standards for Enterprise Analysis? Use of IDEF? What specific projects have these standards been applied to?
- (aa) Do you use a Configuration Management procedure for Modeling methods? How is Integration handled? Maintenance?

- (ab) What paradigms do you use to achieve an integrated environment? What implementation technology are you using (e.g. Flat files, Object Oriented, PLC, etc.)?
- (ac) What requirements does the implementation technology impose on your modeling method?
- (ad) What kind of cost/benefits analysis have you found applicable to your modeling method?
- (ae) Do you distinguish between ASIS and TOBE models? What are characteristics for each?
- (af) Do you model the transition process from the ASIS to the TOBE? What method is used?



### A.3 Source List

#### PRIMARY

- (1) SEMATECH
- (2) CIM/OSA
- (3) EIF Related Contacts  
: EIFWG ,  
EIF/NAD, and EIF/IBM
- (4) NAD

#### OTHER

- (5) PDES
- (6) CALS
- (7) TAM
- (8) Meta Model:
  - (9) Contact #1
  - (10) Contact #2
  - (11) IPI
- (12) Mantech Office
- (13) Boeing
- (14) GUIDE/IBM
- (15) Tool Vendors
- (16) ICAPS
- (17) IMIP/Hanscom  
IMIP/ASD
- (18) SEI
- (19) RAMP
- (20) IDEF User Group
- (21) DAPRO/1291
- (22) Financial Orgs
- (23) CDC
- (24) Automotive (GM, Ford)
- (25) NOSC/IFHAMM
- (26) IMIS
- (27) NIST
- (28) DEC
- (29) DoD TAT Report on Japan
- (30) Teradata, San Francisco
- (31) Northeastern U
- (32) Boeing, Seattle
- (33) MTC, Dayton
- (34) USN, NUSC, Newport
- (35) Peterson Builders, WI
- (36) IBM, Rochester, MN
- (37) DACOM, Irving, TX
- (38) General Dynamics, Fort Worth
- (39) DACOM, Manhattan Beach, CA
- (40) McDonnell Douglas, Long Beach
- (41) Tabset, Berkeley

#### **A.4 Response to Questionnaires**

All of the 41 sources were contacted and provided with the formal list of Framework and Methods questions presented in Section A.2. Many of the sources responded verbally, and their recommendations are included in Strategic Plan Section 4 B.2.

There were 20 written responses received. Of these 20 responses, several contained more than one person's response from the surveyed organization. The types of organizations responding to the questionnaire are categorized according to Table A-1, and the responses are summarized in Figure A-1:

Table A-1. Response Categories

<u>Category</u>	<u>Code</u>	<u>Number of Responses</u>
Industry	I	8
Academia	A	3
Technical Society	T	3
Military	M	2
Consultant	C	4

Type of Organization	Need Identified	Related Recommendation
I (Industry)	Enterprise Scope Add'l IDEF1x Syntax IDEF0/1x Integration Object Orientation Full lifecycle coverage IDEF1x/EXPRESS integ Guidlines & Examples Executable Model	8 6,7 4 8 1 10 11 2,5
A (Academia)	IDEF0/1x Integration Add'l IDEF1x Syntax Object Orientation	4 7 8
T (Tech Soc.)	Add'l IDEF1x Syntax Guidelines & Examples Training/Use Control IDEF0/1x Integration	7 11 9 4
M (Military)	Executable Model Validation Checks Dynamics (IDEF2) Enterprise Scope	2,5 7 2 8
C (Consul'ts)	Add'l IDEF0 Syntax Add'l IDEF1x Syntax Executable Model Enterprise Scope Model Usage Tools	7 7 2,5 8 5

Figure A-1 Summary of Identified Needs from Response

## **APPENDIX B**

### **MEETING MINUTES**

#### **B.1 Kickoff Organizational Meeting**

The initial meeting of the Task 4 Team (the "Kickoff Meeting") took place on Wednesday, May 16. The purpose of the meeting was to: (1) Discuss the background literature thus far collected, (2) Focus on areas for the team to concentrate effort, (3) Plan on-site visits and related activities for the rest of the project, and (4) Determine strategy to meet with AMICE/CIM-OSA.

The Air Force began by establishing the scope of the Task 4 effort to be IDEF0, IDEF1, and IDEF1x. Assessment of IDEF3 and 4 is beyond the project scope.

During the discussion, it was agreed that the results of the assessment were to be presented in the form of requirements. Requirements may influence framework development and stimulate extensions to the IDEF suite of methods. The legacy of existing IDEF models and the lessons learned from user modeling experience must be taken into account. The report should include recommended means of accomplishing change, not just what to change.

It was noted that the Task 4 Assessment effort must have a clearly stated "mission". This mission must clearly show how the effort fits into the mission of the Mantech office.

The list of generic questions was discussed at length. It was decided that the questions should cover two major areas: Frameworks and Methods. It was decided that the draft list of questions would be distributed as a Kit to the team members after the meeting for further additions and changes.

A special-interest meeting was planned for Wednesday evening of the IDEF User Group meeting to solicit input from the members. Written recommendations will be encouraged. Also, a special presentation should be made to the IDEF User Group Steering Committee.

The criteria for evaluating methods was discussed. It was decided that the criteria should include: Investment required, return on investment, preservation of the legacy of existing models, and long-term Air Force needs (how it will help our defense, economic health, etc.).

The Task 4 Assessment project's deliverables were broken down into three areas: the Objectives, the Strategic Plan, and the Recommendations. A draft outline of each of these three areas was generated on an overhead transparency, and a copy distributed before the close of the meeting, for the members to review and revise. The following is a copy of the three first draft slides:

DRAFT SLIDE NO. 1

INITIAL DRAFT OBJECTIVES

- (1) Perform assessment of methods requirements needed to support framework activities
- (2) Identify and prioritize targets of opportunity and voids
- (3) Align task requirements with the long-term MTI goals and objectives
- (4) Develop recommendations and rationale to address potentially high payoff requirements
- (5) Develop a sound and focused coordination strategy for MTI interactions (both inter-agency and government-industry)<sup>2</sup>

DRAFT SLIDE NO. 2

STRATEGIC PLAN

BACKGROUND

Summary of extent of task effort  
Brief assessment of each major framework initiative under way  
Mantech Mission context (related to this task)

VISION STATEMENT

Where is the Industry headed?

- (1) Frameworks
- (2) Methods
- (3) Implementation Technologies (tools and architectures)

RATIONALE

Why the effort is important for the Air Force

NEEDS

Needs forced by the Frameworks  
Other needs

---

<sup>2</sup>This Objective was later removed, as being too ambitious for the project's resources.

DRAFT SLIDE NO. 3

RECOMMENDATIONS

Prioritized

Each recommendation:

- (1) Tied to one or more Needs
- (2) Tied to specific benefits to the Air Force

A single, overall Investment Strategy recommendation

Recommendations broken into TECHNICAL, BUSINESS, AND TECH TRANSFER:

Technical:

WHAT should be done

HOW: Technical Strategy

Business:

WHAT Mantech should be doing

HOW: Investment strategy

Technology Transfer:

WHAT Recommendations that can be carried out by other organizations

HOW: Memoranda of Agreement or Joint Organizational Agreements

**B.2 Rochester, Minnesota CIM-OSA Meeting**

After the CIM-OSA meeting in Rochester, it was decided to develop and distribute a copy of an Executive Summary to key individuals. The Air Force wrote a cover letter to go along with the Executive Summary, and originals of this letter were mailed along with each copy of the document. The Air Force cover letter and the 2-page Executive Summary are included below.



**DEPARTMENT OF THE AIR FORCE**  
**WRIGHT RESEARCH AND DEVELOPMENT CENTER (AFSC)**  
**WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533**

REPLY TO  
ATTN OF:

WRDC/MTIA (2d Lt T. Guss 513-255-7371)

2 Aug 1990

SUBJECT:

Manufacturing Technology Special Studies Task 4

TO: See Distribution List

1. The objective of Task 4 is to assess the requirements on modeling methodologies, and on tools to implement those methodologies, which result from the emergence of overarching national and international frameworks for information system integration.
2. As part of meeting this objective, the Air Force and the Task 4 contractor team consisting of SofTech, CDC, and BDM, are assessing the applicability of the IDEF methods to the Computer Integrated Manufacturing - Open Systems Architecture (CIM-OSA) effort. A recent meeting on this topic was held at the IBM facility in Rochester Minnesota. An executive summary describing the results of that meeting is enclosed for your information.
3. The Air Force Manufacturing Technology Program would like to thank you for your interest in this effort, and will continue to provide you with additional information on future Task 4 findings.

A handwritten signature in cursive script, reading "Todd K. Guss", is positioned above the typed name.

TODD K. GUSS, 2d Lt, USAF  
Air Force Task 4 Program Manager

- 2 Atch
1. Distribution List
  2. Executive Summary

## **EXECUTIVE SUMMARY**

### **A. INTRODUCTION**

#### **A.1 Purpose of the Meeting**

On 20-22 June 1990, IBM's CIM-OSA representatives presented the CIM-OSA concepts to the Mantech Task 4 team. The purpose of the presentation was to gain first-hand understanding of CIM-OSA and to understand the related requirements for Activity and Information modeling, especially relating to IDEF.

#### **A.2 Findings**

The information provided during the meeting was highly beneficial toward accomplishing the purpose. Findings include:

- (1) Present IDEF methods satisfy a significant number of CIM-OSA Life Cycle needs.
- (2) Several additional CIM-OSA needs can be met if specific enhancements are made to IDEF.
- (3) Alignment with the CIM-OSA Framework is needed to make IDEF the "method of choice" by CIM-OSA users.
- (4) A significant number of needed enhancements can be achieved by procedural definitions, and by integrating the existing ICAM System Development Methodology (SDM) with IDEF.

The Rochester meeting also pointed out the need for technical discussions directly with CIM-OSA Framework Project experts. These discussions are needed to clarify detailed technical issues, to verify the Task 4 Team's preliminary findings, and to elaborate specific areas of IDEF support for CIM-OSA.

### **B. TOPICS DISCUSSED**

Key technical topics discussed at the meeting include: 1) CIM-OSA Framework Project update based upon IBM's understanding, 2) mapping of CIM-OSA modeling requirements with IDEF Activity and Information Modeling capabilities, 3) IBM's experience using IDEF for internal modernization projects (independent of CIM-OSA considerations), and 4) identification of IDEF shortfalls and enhancement needs based upon CIM-OSA Framework application. Each of these topics is expanded upon briefly, below.

#### **B.1 CIM-OSA Framework Update**

The AMICE Project of CIM-OSA is attempting to establish a CIM Open System Architecture that will enable enterprises to perform business improvements in a real-time adaptive mode. The scope of the



architecture covers all types of applications and complies with evolving technologies.

Discussions in Rochester addressed: architectural principles, structuring concepts, flexibility, basic architectural elements, functional viewpoints, informational viewpoints, and organizational issues. A PC-based "storyboard" presentation was used to introduce CIM-OSA concepts, and detailed discussions were held on key technical topics (Framework "cube" elements, key CIM-OSA terms, definition and relationships between CIM-OSA "constructs", etc.).

## **B.2 CIM-OSA/IDEF Mapping**

The IDEF method was mapped to the requirements, design, and implementation phases of the CIM-OSA life cycle steps. The assessment determined that IDEF partially or wholly supports more than 50% of the steps.

<b>CIM-OSA Phase</b>	<b>CIM-OSA Step</b>	<b>Supported by Idef</b>	<b>Not Supported by Idef</b>
Requirements	20	15	4 Behavior 1 Integration 4 Resources
Design	9	5	
Implementation	9	N/A	

The results of the mapping exercise show a high degree of IDEF support for the requirements and design phases. Furthermore, a limited number of enhancements will significantly improve the opportunity to apply the methodology on a much broader basis.

## **B.3 IBM's IDEF Experience**

IBM was asked to present all positive and negative IDEF usage experiences. The positive points outnumbered the few negative points. In general, IBM has found IDEF very helpful and has adopted it as the corporate "method of choice" for internal CIM Projects, including "IBM Worldwide".

Specific points mentioned include: IDEF provides rigor to analysis efforts, which had been lacking prior to IDEF use; IBM has developed courses which are now available for in-house IDEF training; present IDEF User Manuals are insufficient for a complete understanding of the full role and application of IDEF; IDEF should be driven by a "repository of IDEF models" to reduce startup efforts; the inclusion of an experienced IDEF modeler on the staff of each new IDEF project is critical; management support of an IDEF project is critical; the computer-supported "living model" concept is a helpful aspect of CIM-OSA that should be carried over to IDEF.

## **B.4 IDEF Shortfalls and Enhancements**

Several IDEF shortfalls were identified based upon IBM experience (both from internal IDEF use, and as related to CIM-OSA). The top five enhancements aimed at correcting current IDEF shortfalls were:

- (1) Integration of the ICAM System Development Methodology (SDM) with the IDEF0, IDEF1, and IDEF1x methods and training manuals.
- (2) Enhancement of the IDEF models to be executable at the Design level.
- (3) Construction of an IDEF1x information model, using the CIM-OSA templates for model focus.
- (4) Integration of IDEF0 and IDEF1 by cross-correlation of related elements.
- (5) Validation and formalization of the syntax, semantics, and pragmatics of the identified enhancements.

#### C. SUMMARY

There is a growing need for methods that support analysis, design, and integration efforts. IDEF has already been shown to meet these needs within the DoD industrial community. An opportunity now exists to position IDEF to meet equivalent needs in the broader industrial community. Improvements to the existing methodology can be leveraged for increased benefits to the DoD and to industrial IDEF users to better meet the challenges of Computer Integrated Manufacturing as envisioned for the decade ahead. Furthermore, the significant investments in IDEF development and application can serve as the stepping-stone which build upon the Air Force investment and make use of the valuable legacy of IDEF models and IDEF communications capabilities already established in industry.

The CIM-OSA meeting in Rochester was a significant step in accomplishing this vision by providing the opportunity to probe into the specific IDEF enhancements that are needed to meet this challenge. The results of this meeting will serve very well as a basis for further detailing technical points with representatives of the AMICE Project, and in cementing CIM-OSA cooperation with the IDEF community.

### **B.3 July Working Session**

The meeting convened with the following purpose and objectives: to review and discuss the findings to date, to plan the remainder of the work to be accomplished, to lay out the structure of the final report, and to begin work on elements of the final report.

#### **I. REVIEW OF STATUS**

##### **A. Solicitation of IDEF Enhancement Needs**

At a previous meeting, assignments had been made to each of the three contractors to contact a list of information sources regarding IDEF enhancements. A solicitation letter had been developed and distributed to the contractors, for use in this solicitation.

A review of the status of this effort revealed that the effort is behind schedule. The following table summarizes the status as of the July 23 meeting:

<u>Info Sources</u>	<u>Number Contacted</u>	<u>Awaiting Responses</u>	<u>Responses Received</u>
41	18	12	6

All contractors agreed to put an extra effort into completing the information-gathering effort as soon as possible. To speed up the process, it was agreed that those information sources who had submitted business cards in response to the announcement during the May IDEF User Group meeting, need not be contacted by telephone individually before being sent the solicitation letter. This will permit 8 of the "uncontacted" sources to be sent letters immediately; this should speed up the process significantly.

It was agreed that the goal of the solicitation is to contact everyone on the list. The Task 4 group cannot guarantee receiving responses from everyone, but everyone must have been contacted before the solicitation task can be considered complete.

However, even with the new procedure in place, it was clear that the schedule is not feasible, and that a no-cost extension of the Period of Performance is in order. This was agreed to, and the process of obtaining an extension will be pursued as an action item for SofTech.

##### **B. Completion of the Executive Summary of the Rochester CIM-OSA Meeting**

It was agreed that the latest draft of the Executive Summary was acceptable, except for Section B.2 (CIM-OSA/IDEF Mapping). This needs to state the findings in a clearer way for the level of readership anticipated. The group worked on re-wording this section during the session set aside for "Work on Individual Report

Sections". The resulting new section was entered into the master file, re-printed, and distributed to the attendees at the start of the July 24 session.

The reasons for IDEF not supporting individual CIM-OSA life cycle steps broke down into three categories: Behavioral Aspects (4 steps), Integration (1 step), and Resources (4 steps). This succinctly summarizes the voids in the IDEF methods from a CIM-OSA perspective. The Executive Summary will be distributed to a list of key government and industry representatives.

## **II. DISCUSSION OF THE FINAL REPORT LAYOUT, CONTENT, ASSIGNMENTS**

The Final Report outline was discussed and modified. It was agreed that the first drafts of all sections would be submitted by August 10, and the summarized complete draft submitted by August 15.

The following is the revised outline, showing the estimated size of each section and the person responsible for writing the first draft of the section.

### **III. WORK ON INDIVIDUAL REPORT SECTIONS**

With the work on the Executive Summary, the time allotted to this effort was reduced. However, before the end of the session, the Final Report Section 2, "Industry Directions", was partially written and distributed to the team members.

### **IV. RECOMMENDATIONS:**

The status of the recommendations identified as a result of the Task 4 assessment to date was summarized in the following list of 8 recommendations (subsequently increased to 11):

1. Integrate ICAM and SDM into IDEF Suite
2. Enrich IDEF models sufficiently to be executable at design level
3. Construct an IDEF1x data model of CIM-OSA templates
4. Integrate IDEF0 and IDEF1x
5. Develop more design-level packaging/structuring constructs
  - (a) Data Flow concepts -> Activity Models
  - (b) External and Internal data structuring concepts (screens/reports)
6. Concepts and Tools to support re-use and Configuration Management of IDEF Models
  - Re-use
  - CM
  - Training
  - Clarification
  - Simulation (Timing/Performance analysis)
  - Cost Benefit analysis
  - Impact analysis
  - Integration Characteristics
7. IDEF0 and IDEF1x usability enhancements and extensions derived from experts and users in practise

8. Usage definition/Rule sets (Examples and Training)  
(Enrich IDEF0 and IDEF1x with constructs or rule sets to permit modeling and specification of behavior)

Note: includes two types of rule sets: "How to Model" rule set for developing models, and "IF-Then" type rules for developing CIM.

## **V. PLANS AND ACTION ITEMS**

### **A. Plans for the Next meeting (August 20)**

The next Task 4 Team Meeting will be held in Dayton on August 20, the day prior to the IDEF User Group Steering Committee meeting. The purpose of the meeting will be to assess project status and to review Task 4 presentation material. The scheduled submission of the draft Final Report sections by August 10 is the key Action Item that will make this schedule feasible.

### **B. Plans for User Group presentation in February**

It is anticipated that the Steering Committee presentation will provide the basis of a presentation to be made to the full User Group at their next meeting. By that time, the Final Report should be completed, and the full User Group should be informed regarding the results of the Task 4 effort.

## **VI. HANDOUTS**

At the start of the July 24 session, several handouts were distributed to the task 4 team:

- IDEF0 Model of Framework Tasks
- Recommendations from the Solicitation
- Draft Rochester Trip Minutes
- Revised Executive Summary of Rochester Meeting
- CIM-OSA Response to the AF Letter of Intent
- Mantech Objectives Material
- Final Report draft material

### **B.4 August Meeting and IDEF Steering Committee Presentation**

On August 20, the Task 4 Team met just prior to the IDEF User Group Steering Committee meeting, to prepare a presentation of the draft recommendations to that group. The following is the list of overhead slides presented to the Steering Committee on August 21.

- (1) Task 4 Objectives
- (2) Description of Work
- (3) Needs Solicitation
- (4) Reports & Communities Surveyed
- (5) IDEF0 Diagram of the Project tasks
- (6) Gantt Chart of the project timetable
- (7) Relation to CIM-OSA
- (8) Purpose of the IDEF-UG Framework
- (9) Framework Cell relationship to methods
- (10) Benefits Resulting from Framework Use
- (11) IDEF Family of Methods
- (12) Method Enhancement DO's and DON'Ts
- (13) The eleven recommendations

The majority of the question and answer session was occupied by a discussion of the eleven recommendations. Following the meeting, the Task 4 Team agreed that the presentation material would serve as a basis for future presentations of the Task 4 findings.

#### **B.5 Final Task 4 Team Meeting**

The Task 4 Team met for the last time on November 13 for the purpose of making final changes to the Final Report document. Lt. Guss was unable to attend.

The editing pass over the draft final report was provided by BDM, and this material was turned over to SofTech for processing. A revised, standardized format was recommended for the Final Report, and it was noted that the Task 4 report would now have the same format as the Task 5 report.

Several issues were decided:

- An introduction to the Executive Summary was developed, to set the charter and scope of the Task 4 effort before describing the accomplishments.
- The Executive Summary's new categorized list of recommendations was discussed. It was decided that this is an acceptable middle position



between including each recommendation (too lengthy) and providing a brief summary (too short).

- CDC recommended that the Roadmap Chart be included full-size on a separate page, since it is very small print and is likely to become unreadable after multiple copying.
- The draft survey of available COTS tools related to the IDEF methods was submitted. The Team members had several additions to the draft list of COTS tools.
- The new matrix "mapping problems to solutions" (Figure 4-1) was edited and expanded.

A request was made that, once the changes have been made, the Task 4 Team wishes to have a final draft to review one more time, before submitting the Final Report to the Air Force.

#### **B.6 IDEF User Group Meeting**

Although not strictly a Task 4 Team meeting, material from the session held at the IDEF User Group Meeting in May is included here. A synopsis of the meeting is included above, in Section 5.A "IDEF User Group Meeting".

There were four overhead projector slides developed for and used at the special Task 4 Wednesday evening session. These slides summarize the goals, objectives, and strategic plan outline. The material from the slides is included here for the record. Also, it is anticipated that the material will be useful when presenting Task 4 to other groups in the future.

## SLIDE 1: OVERVIEW

Air Force Sponsored Assessment to Identify and  
Prioritize  
Activity & Information Modeling Enhancements

### OVERVIEW

- Team Effort - SofTech, CDC, BDM, DEC
- Assessment Information on Enhancements
- Perform Assessment
- Prioritize Recommendations & Strategy
- Present Report to IDEF UG & WRDC
- Five Month Effort

## SLIDE 2: OBJECTIVES

### OBJECTIVES

- Assess Framework Initiatives and Identify Requirements for Improved IDEF Support (Activity & Info)
  - SEMATECH
  - CIM-OSA
  - Others
- Develop Strategic Focus with Investment Strategy
- Prioritize Targets of Opportunities
- Identify Lessons Learned
- Prepare Results
  - Technical
  - Business

### SLIDE 3: STRATEGIC PLAN OUTLINE

#### DELIVERABLES:

##### Strategic Plan

- Background
- Vision Statement
  - Industry Directions and Needs
- Rationale for Effort
- Needs
  - Framework Driven
- Recommendations
  - Description
  - Related Need(s)
  - Benefits
  - Business Strategy

Directed to: WRDC/MTI  
IDEF-UG

### SLIDE 4: SOLICITATION OF RECOMMENDATIONS

#### YOU CAN HELP!

-

#### YOU CAN BENEFIT!

- Provide Your Ideas and Insights Associated with Framework Driven IDEF Requirements (Activity & Info)
- Provide Suggested Points of Contact for Further Insight
- Provide "Lessons Learned" Experience
- Identify Documents/Information You Can Send

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THE COMPILED RESULTS WILL BE PROVIDED TO THE  
IDEF-UG FOR UG PARTICIPANT ACTIVITIES.

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## **APPENDIX D**

### **CIM-OSA/Idef MARRIAGE**

#### **D.1 IBM Document**

(See next page)

## CIM-OSA Life Cycle and IDEF

Table 1 (Page 1 of 4). CIM-OSA Life Cycle and IDEF Support		
CIM-OSA LIFE CYCLE METHODOLOGY	IDEF ENFORCED	IDEF RECORDING MECHANISM
Requirements Phase		
Assign Responsible Design Authority	PARTIAL	<ul style="list-style-type: none"> <li>• Author recorded on IDEF cover sheet.</li> <li>• Responsible Design Authority not necessarily recorded</li> </ul>
List the objectives and Constraints	PARTIAL	Control arrows on diagrams
Formalize the objectives and constraints	NO	
Identify DOMAIN Processes that address the objectives and constraints	YES	IDEFo Activities
Identify DOMAIN for the DOMAIN Process Functions	YES	A-0 Diagram
Identify the Object Classes	YES	Inputs, Outputs and Controls on Diagrams
Ensure DOMAIN Object Classes are refined to the DOMAIN Process level	YES	Inputs, Outputs and Controls on Diagrams
Identify sources and destinations of external Object Classes and their external DOMAINS.	YES	A-1 Diagrams
Identify DOMAIN RELATIONSHIPS	PARTIAL	A-1 Diagram
Define functional part of DOMAIN and DOMAIN PROCESSES (first level decomposition)	PARTIAL	Description of functions and I/O provided in text
Define the Behavioral Part of the DOMAIN	NO	
Decompose the DOMAIN PROCESSES	YES	IDEFo Diagrams

Table 1 (Page 2 of 4). CIM-OSA Life Cycle and IDEF Support		
CIM-OSA LIFE CYCLE METHODOLOGY	IDEF ENFORCED	IDEF RECORDING MECHANISM
Identify/refine object classes for the business process level	YES	Inputs, Outputs and Controls on diagrams
Define functional part of the business processes	PARTIAL	Description of function and I/O provided in text
Define the Behavioral Part of the DOMAIN Processes	NO	
Decompose the business processes (enterprise activities)	PARTIAL	<ul style="list-style-type: none"> <li>Activities cannot be shared in IDEF</li> <li>Can be made possible if SADT (System Analysis and Design Technique) Calls are incorporated in IDEF.</li> </ul>
Identify/Refine Object classes for the enterprise activity level	YES	Inputs, outputs, controls on diagrams
Define functional part of the enterprise activities	PARTIAL	Description of function and I/O provided as text
Define the behavioral part of the business processes	NO	
Identify OBJECTS	YES	IDEFo Flows
Derive the external schema	NO	
Identify INFORMATION ELEMENTS	NO	
Design Phase		
Assign Responsible Design Authority	PARTIAL	<ul style="list-style-type: none"> <li>Author recorded on IDEF cover sheet.</li> <li>Responsible Design Authority not necessarily recorded</li> </ul>



Table 1 (Page 3 of 4). CIM-OSA Life Cycle and IDEF Support		
CIM-OSA LIFE CYCLE METHODOLOGY	IDEF ENFORCED	IDEF RECORDING MECHANISM
Identify alternative resources for Required Capability listed with each EA.	NO	ICAM System Development Methodology (SDM) addresses but is not part of the IDEF users manual.
Define Alternative or refine existing EA's	NO	
Select from alternatives	PARTIAL	IDEFo Mechanisms (not quantitative)
Define the EA functional operations based on the resource analysis	NO	<ul style="list-style-type: none"> <li>Activities cannot be shared in IDEF</li> <li>Can be made possible if SADT (System Analysis and Design Technique) Calls are incorporated in IDEF.</li> </ul>
Specify Resource and Capacity	PARTIAL	IDEFo Mechanisms (not quantitative)
Derive the conceptual schema	YES	IDEF1x Diagrams/Text
Derive consistency constraints	PARTIAL	Cardinality, Referential Integrity, Entity Integrity
Identify I/O volumes for each functional operation	NO	
Implementation Phase		
<ul style="list-style-type: none"> <li>Choose products</li> <li>Define implemented capabilities</li> <li>Define locations</li> <li>Define dynamics</li> </ul>	NO	ICAM SDM addresses but it is not part of the IDEF users manual
Define fragmentation and distribution of data	NO	
Define Implemented Functional Entities	NO	
Define communication requirements	NO	

Table 1 (Page 4 of 4). CIM-OSA Life Cycle and IDEF Support		
CIM-OSA LIFE CYCLE METHOD- OLOGY	IDEF ENFORCED	IDEF RECORDING MECHANISM
Define communication resources	NO	
Describe how to store per data location and develop internal schema	NO	
Define storage resources	NO	
Select Products	NO	

## D.2 Task 4 Team Document

This paper is a limited comparison of the IDEF and CIM-OSA methodologies. It identifies several of the outcomes from the document presented by IBM Corporation entitled, The CIM-OSA and IDEF Marriage, and the discussion regarding the IBM document at meetings held in Rochester, Minnesota.

The overall outcome of this comparison and/or analysis of the two methodologies agrees with that offered in the IBM document as it stated that IDEF can support the CIM-OSA methodology with some minor revisions. The CIM-OSA methodology does provide for several areas that the IDEF methodology does not provide for, but IDEF also provides for areas not addressed in CIM-OSA. The area (at a methodology overview level) where IDEF offers the user an advantage over CIM-OSA is that of executive level strategic planning. The areas that (at a methodology overview level) where CIM-OSA offers the user an advantage over IDEF include the generation and use of reference models, the implementation phase coverage, and the behavioral aspects built into the models which can be used for day-to-day control of operations.

Additional information regarding the 38 CIM-OSA Life Cycle Steps, as outlined in the IBM document, is given below. This information supplements and expands upon the information provided by SofTech in the minutes of the Rochester, Minnesota meeting.

### STEP - DISCUSSION OF STEP

#### REQUIREMENTS PHASE

1. Assign Design Responsibility - CIM-OSA requires that the author/designer of the model be assigned and called out in addition to the owner of the process being modeled.

IDEF requires that the author of each diagram be assigned but does not require the assignment of the owner of the process nor the designer of the process. IDEF does allow for this assignment but at this time does not require it.

To make the two methodologies compatible, IDEF could be augmented with a template or cover sheet that would set the requirements for each model. Included in this cover sheet would be the requirement to use the existing capability to call out the owner of the process being modeled.

2. Identify/Formalize Objectives and Constraints - This step in the CIM-OSA methodology requires additional clarification for the terms used. The assessment team was unfamiliar with the definitions of Objectives and Constraints as they relate to CIM-OSA. CIM-OSA does have the capability for dynamic flow requirements which enable it to be used as a simulation tool.

IDEF would require additional information, forced through the aforementioned coversheet/template, in order for it have the ability for simulation or dynamic flow characteristics.

Additional definition/clarification of CIM-OSA Objectives and Constraints is required prior to having a complete analysis of this step.

3. Identify Functions to address the Objectives and Constraints - The activities within IDEF cover the CIM-OSA Objectives and Constraints as understood by the assessment team. The activity identification process within IDEF is capable of identifying the functions that address the Objectives and Constraints within CIM-OSA.
4. Identify the Object Classes required by the Functions - CIM-OSA does not contain all of the object classes required by IDEF. IDEF requires Inputs, Outputs, and Controls classifications as opposed to CIM-OSA requiring only Inputs and Outputs classifications.

Interpretation and definitional differences may exist in addition to style differences between the two methodologies' Object Classes, thus requiring additional information prior to determining a match or mismatch of the methodologies.

5. Define the Domain Process - Both methodologies define the Domain Process for the models created, but IDEF does not distinguish between the Domain Process and the Enterprise Activity.

Both methodologies have a required scoping activity that defines the Domain Process for each model.

6. Define the Domain Processes Functional Characteristics - The Functional Characteristics of the Domain Process in CIM-OSA are dynamic in nature and are in proper form to be simulated with time and dependency variables included.

IDEF has the inherent capability to provide this information in a functioning format, but would require additional syntax in order for the Inputs and Outputs to be functional in nature. This is now required when an IDEF model is being prepared for simulation.

7. Define Domain - Both methodologies require a Domain to be defined. The IDEF methodology defines the Domain through a Top-Down approach, with the Domain being defined by, and within, the A-1 Diagram. CIM-OSA defines the Domain from a Bottom-Up approach.

Although the methodologies arrive at the Domain Definition from opposite directions, they both do require a definition that could and should be very similar.

8. Define the Domain Relationship - CIM-OSA requires the dynamics of the Inputs to be included in addition to the external environment. This includes the frequency of the inputs and dependency relationships.

IDEF defines the external environment in the A-1 diagram but does not define or identify frequency.

The constraint arrows within IDEF would need to be quantified and defined as flow arrows in order for IDEF to fill the CIM-OSA methodology's requirements for Domain Relationship definitions.

9. Define the Business Process - The decomposition process within IDEFo defines the Business Process similarly to the definition required in CIM-OSA.
10. Refine the Object Classes to the Business Process Level - The diagrams within IDEFo show the Object classes at the Business Process Level. This refinement of the Object Classes meets the requirements of CIM-OSA as understood at this time.
11. Define the Business Processes Functional Characteristics - Similar discussion as in STEP #6.
12. Identify the Enterprise Events - CIM-OSA requires procedural triggers or events with related and dependent results as its Enterprise Events. This information makes the model event dependent or in simulation format.

IDEF does not include dependent events as arrows as required in CIM-OSA. In order for IDEF to meet the requirements in CIM-OSA, additional capabilities would have to be built into the methodology.

The CIM-OSA definition of Enterprise Events requires additional clarification prior to a thorough discussion in relation to the IDEF methodology by the assessment team.

13. Define the Domain Process Behavior for each Enterprise Event - CIM-OSA requires a dynamic behavior that is not found in IDEFo or IDEF1. IDEF2 has the activation rules that compare to the requirements of CIM-OSA, but IDEF2 has been shelved and replaced by the simulation tool, SLAM II. SADT also has activation rules in place that may meet the CIM-OSA requirements, but stand-alone IDEF does not have this capability at this time.
14. Define the Enterprise Activities - With the addition of call arrows, IDEF could meet the requirements of CIM-OSA with respect to the definition of the Enterprise Activities.
15. Refine Object Classes to the Enterprise Activity Level - Similar discussion as in STEPs #4 and #10.

16. Define the Enterprise Activity Functional Characteristics - Similar discussion as in STEPS #6 and #11.
17. Refine the Enterprise Events - Similar discussion as in STEP #12.
18. Define the Business Process Behavior for each Enterprise Event - Similar discussion as in STEP #13.
19. Identify the Objectives for the Enterprise Activities - IDEF data flow analysis identifies flows and relationships that seem to correspond directly to the requirements for Object Views within the CIM-OSA methodology.
20. Identify the Data Elements for each Object - CIM-OSA decomposes the Data Elements to their lowest level of use (the entry on a form vs the name of the total form) for each Object.

The Data Elements identified on the arrows within IDEF are decomposed no further than the identified activities. IDEF could be modified to require this extra decomposition.

The decomposition of the arrows would assist in the assurance of consistency that is sometimes lacking in IDEF. The decomposition is covered at the Entity level in IDEF instead of at the Element level, as required by CIM-OSA.

#### DESIGN PHASE

21. Assign Design Responsibility - Similar discussion as in STEP #1.
22. Define the Alternative Resources to Address the EA Required Capabilities - CIM-OSA requires rate and usage information as part of its resource requirements. Additionally, information regarding the size of computing resources and other size or amount requirements need to be identified in CIM-OSA.

Alternative resource requirements are also required for CIM-OSA.

IDEF lists only the types of resources without relation to size, quantity, or usage rates. Alternative resource requirements are not inherent to IDEF and must be added through the use of ICAM SDM in order for IDEF to meet the requirements of CIM-OSA.

23. Define/Refine EA's based on Resources Considered - Within CIM-OSA is a decision process capability which can change the Enterprise Activity according to the resources available.

IDEF does not have the capability, because of the lack of resource definition, to apply a decision making process that can change an Enterprise Activity.

24. Define the Conceptual Schema - With the addition of the CDM implementation tool, IDEF has the capability to define the Conceptual Schema as required by CIM-OSA.
25. Select the Resources to Address the EA Required Capabilities - IDEF does not show or identify quantities as is required by CIM-OSA. IDEF can meet the CIM-OSA requirements when SDM is used with IDEF. The mechanisms in IDEFo identify the resources required for an independent activity but not the quantity.
26. Define the Consistency (Data Integrity) Constraints from Consistency Rules - IDEF meets the CIM-OSA requirements partially by offering Cardinality Rules and definitions/constraints for Referential and Entity Integrity. Additionally, BDM offers an Equivalence of Path capabilities during modelling.

(The group discussed their feelings that the existing IDEF tools are oversold in their ability to maintain Reference and Entity Integrity, although the IDEF methodology accounts for the maintenance of integrity.)

27. Specify New/Additional Resources to Address the EA Required Capabilities - As in STEP #s 22 and 25, IDEF offers resources information but not in a quantity format through the use of SDM.

STEP #s 22, 25, and 27 need additional clarification from CIM-OSA prior to any additional analysis between IDEF and CIM-OSA.

28. Define Functional Operations - Similar discussion as in STEP #s 5, 9, and 14.

The CIM-OSA methodology requires actual time based process to be identified within the model.

IDEF requires the addition of Call Arrows in order for it to be able to meet the CIM-OSA requirements of showing time based functional relationships.

29. Define I/O Volumes for each Resource Location - IDEF does not require volume, quantity, nor usage when identifying Inputs and Outputs.

In CIM-OSA, the resources applies may dictate the activity volume of the entity, thus requiring volume, quantity, and usage information.

#### IMPLEMENTATION

30. Define Implementation Responsibility - Similar discussion as in STEP # 1.
31. Select Products to Implement the Resources/Components and Define Implemented Capabilities - STEP #s 22, 25, 27, and 31 may include

an extra step in the selection and specification of resources for implementation as the assessment team now defines them. Clarification of these steps is required prior to additional, meaningful analysis being offered.

IDEF requires additional scope to meet the assumed requirements of CIM-OSA. This additional scope may come in the form of BDM's Strategic Planning Methodology (SPM), which assists in the selection of resources/components.

32. Define Data Fragmentation - CIM-OSA defines and identifies where data is located geographically.

IDEF is does not offer data location (distribution of data) identification.

33. Define External Schema - With the use of CDM (from IISS program) as an implementation tool, IDEF can define the External Schema as required in CIM-OSA.
34. Define how the Data is to be Stored - IDEF does not cover how or where data is stored nor the communication requirements as is required by CIM-OSA.
35. Select Products to Implement Data Storage - Similar discussion as in STEP # 34.
36. Define Communication Requirements - Similar discussion as in STEP # 34.
37. Select Products to Implement Communication Requirements - Similar discussion as in STEP # 34.
38. Define the Internal Schema - Similar discussion as in STEP # 33.